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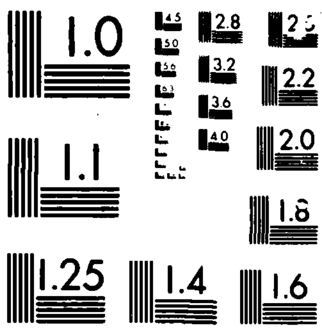

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ESTIMATION OF INVENTORY ITEM DEMAND
DISTRIBUTIONS: MODELING ITEM
MIGRATION AT THE DEFENSE ELECTRONICS
SUPPLY CENTER

THESIS

Kevin P. Smith
Captain, USAF

AFIT/GOR/OS/85D-18

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ABSTRACT

The objective of this research is to simulate the migration of items between management categories in a large inventory system. The approach taken is to model demand from distributions created by grouping items rather than from individual demand distributions. Items are grouped according to characteristics such as demand frequency, average requisition size, and price. An extensive historical database is used to develop the simulation input distributions and to compare simulation results against actual inventory system demand and migration figures. The empirical requisition size and daily demand distributions exhibit non-random tendencies and extreme values which cannot be modeled using common theoretical distributions. Simulated demand and migration is dependent on the characteristics used to define the item groups. Simulated item migration occurs, but is not representative of the actual migration present within the item sample. Keywords: [illegible] analysis, Statistical analysis, statistical distributions, data acquisition, [illegible], computer programs.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for Public Release; Distribution Unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GOR/OS/85D-18	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION School of Engineering 6b. OFFICE SYMBOL (If applicable) AFIT/ENS	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code) Air Force Institute of Technology Wright-Patterson AFB OH 45433	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS. PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT NO.
11. TITLE (Include Security Classification) See Box 19	

12. PERSONAL AUTHOR(S)
Smith, Kevin Peter, Capt, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
MS Thesis	FROM ____ TO ____	1985 December	363

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	Inventory Analysis, Simulation, Statistical Analysis, Statistical Distributions
15	05		
12	01		

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Title: Estimation of Inventory Item Demand Distributions: Modeling Item Migration at the Defense Electronics Supply Center

Thesis Advisor: Palmer W. Smith, Lt Col, USAF

Approved for public release: IAW AFR 190-1.
Lynn Wolaver 13 Feb 86
LYNN E. WOLAVER
Dean for Research and Professional Development
Air Force Institute of Technology (ATC)
Wright-Patterson AFB OH 45433

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Palmer W. Smith, Lt Col, USAF	22b. TELEPHONE NUMBER (Include Area Code) (513) 255-3362 22c. OFFICE SYMBOL AFIT/ENS

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE

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SECURITY CLASSIFICATION OF THIS PAGE

AFIT/GOR/OS/85D-18

ESTIMATION OF INVENTORY ITEM DEMAND DISTRIBUTIONS: MODELING ITEM MIGRATION AT THE DEFENSE ELECTRONICS SUPPLY CENTER

THESIS

Presented to the Faculty of the School of Engineering
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science

Kevin P. Smith, B.S.
Captain, USAF

December 1985

Approved for public release; distribution unlimited

Preface

The inventory simulation model currently in use at the Defense Electronics Supply Center does not provide an adequate representation of the migration of inventory items among management categories. The purpose of this thesis is to develop and test a technique for modeling inventory item migration.

I would like to thank the personnel of the Defense Electronics Supply Center: Mr. Robert Gumbert, Mr. Anthony Elkins, Mr. Nanda Balwally, and especially Mr. Robert Bilikam for allowing me to draw on their knowledge and experience. A special thanks to my advisor, Lt Col Palmer Smith, for his continuing patience, insight and assistance in times of need. I would also like to thank Mr. Frank Bakos for his invaluable assistance.

Above all, I wish to thank my wife Debbie for her help in proofing this thesis and her support during the entire program.

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Abstract

The objective of this research is to simulate the migration of items between management categories in a large inventory system. The approach taken is to model demand from distributions created by grouping items rather than from individual demand distributions. Items are grouped according to characteristics such as demand frequency, average requisition size, and price. An extensive historical database is used to develop the simulation input distributions and to compare simulation results against actual inventory system demand and migration figures. The empirical requisition size and daily demand distributions exhibit non-random tendencies and extreme values which cannot be modeled using common theoretical distributions. Simulated demand and migration is dependent on the characteristics used to define the item groups. Simulated item migration occurs, but is not representative of the actual migration present within the item sample.

ESTIMATION OF INVENTORY ITEM DEMAND DISTRIBUTIONS: MODELING ITEM MIGRATION AT THE DEFENSE ELECTRONICS SUPPLY CENTER

I. INTRODUCTION

Background

Almost all large business concerns maintain an inventory of goods for future use. The costs associated with maintaining an inventory include: ordering costs, warehousing costs, and the opportunity cost associated with the investment in inventory versus some other area. In addition to the cost of maintaining inventory there is also a cost associated with not maintaining inventory (i.e., the cost of unsatisfied demand for inventory items). The goal of inventory models is to obtain a balance between inventory holding costs and the costs of unsatisfied demand.

The difficulty encountered in attempting to obtain this balance is the uncertainty associated with the future conditions under which the inventory system will operate. Future demand, prices, lead-time (the time it takes for items which are ordered to be delivered), and the costs of unsatisfied demand are all subject to future uncertainties.

Especially in large inventory systems, future uncertainties coupled with the complexities associated with

the inventory system itself make it difficult to evaluate the effects of proposed changes to the system. Changes in the level of funding available, the inventory model or models used, or some other system specific change must be evaluated before implementing what could be a disastrous policy. A tool often used to make evaluations of large inventory systems is the simulation model.

A simulation model can be modified to reflect whatever change is being proposed. The results of simulating the effects of the proposed change can be used as one of the inputs to the decision of whether or not to implement the change.

Simulation of an inventory system requires development of a set of inputs which provide a good approximation of the conditions which would actually occur. The inputs to an inventory simulation model include: demand for the items (both the number of orders and the quantity those orders represent), lead-time for inventory orders, inventory item prices, warehousing costs, transportation costs, etc. As a decision aid, simulation model output can only be useful if realistic inputs are used.

Simulation is one of the analysis tools employed by the Operations Research office of the Defense Electronics Supply Center (DESC). DESC, one of six inventory control points within the Defense Logistics Agency, manages over 900,000 inventory items for the Department of Defense. As of the

start of 1985 the dollar value of inventory maintained by DESC was just under 1.5 billion dollars (8:5).

As in many large inventory systems, DESC employs an item classification scheme which permits different categories of items to receive different levels of management attention. The level of management attention an item receives is directly related to the dollar value of the demand for the item. DESC uses two main item categories: Numeric Stockage Objective and Replenishment. Replenishment items are further broken down into four subgroups: Low, Medium, High 1, and High 2. The number of requisitions (orders), level of demand quantity, and level of demand value (unit price * demand quantity) used to define the categories are summarized in Table 1.1.

DESC employs a simulation model to evaluate many aspects of its inventory management system including alternative inventory control policies. One problem with the current simulation is that it does not adequately model the migration of inventory items from one management category to another.

Item migration is the movement of inventory items from one item category to another over time. At DESC, migration is commonly defined with respect to one fiscal quarter. For instance, an item which is categorized as Numeric Stockage Objective in one quarter is said to have "migrated" if its actual demand and demand value in the next quarter qualify

TABLE 1.1

ITEM CATEGORIES

	Annual Requisitions (AR)		Annual Demand Quantity (ADQ)*		Annual Demand Value (ADV)*
Numeric Stockage Objective	AR < 3	or	ADQ < 12	or	ADV < $20
Replenishment	AR ≥ 3	and	ADQ ≥ 12	and	ADV ≥ $20
Low					$20 < ADV ≤ $400
Medium					$400 < ADV ≤ $4500
High 1					$4500 < ADV ≤ $15000
High 2					$15000 < ADV

(Source: adapted from 14:31)

*For replenishment items, categorization is based on or forecasted levels of ADQ and ADV; whereas, for Numeric Stockage Objective items the actual ADQ and ADV are used.

it for another category.

The amount of item migration at DESC was studied by Lt Col Palmer Smith, USAF, and Mr. Robert Gumbert of the DESC Operations Research office. They calculated total migration among management categories over a four year period. Their findings indicate a significant amount of migration is taking place. For example, in one of the six categories considered, there were 375,922 migrations into the category and 392,819 migrations out of the category (24:2). From their findings, Smith and Gumbert conclude that the magnitude of migration "mandates migration be embedded into our simulation models so that it is considered when simulating buy policies, inventory management decisions,

budget execution and in evaluating supply effectiveness" (25:18).

The Operations Research office at DESC is currently involved in development of a new simulation model. One of the goals for the new simulation is an improved representation of the demand for inventory items and the migration of inventory items among DESC management categories.

Problem

Item migration is not adequately modeled in the DESC inventory system simulation. The inadequate representation of item migration in the simulation process makes the validity of model results questionable. The specific problem addressed in this research is the estimation of inventory item demand distributions from historical data maintained at DESC. These distributions will be used as inputs in the new DESC simulation model to provide a more realistic representation of inventory item demand and migration.

Research Question

What are the demand distributions of DESC inventory items and how well will demand distributions estimated from historical data model future demand for inventory items and the migration of items among DESC inventory management categories?

Objective

The overall objective of this research is to improve the demand inputs to the DESC simulation model. The hypothesis to be tested is whether the estimated demand distributions will provide a realistic model of inventory item demand and migration at DESC. Specific sub-objectives are:

1. Collect and analyze historical demand data to define groups of items with similar characteristics.

2. Develop a procedure for estimating the demand distributions of DESC inventory items in the groups established in sub-objective 1.

3. Develop a model to simulate demand for a sample of DESC items using the estimated distributions.

4. Compare the item migration produced by simulated demand against actual DESC migration data to determine how well the actual migration is being modeled.

Scope

The analysis is limited to a sample of the available inventory items. The sample chosen was one already created by DESC for use in past simulation efforts. This set of inventory items is a stratified sample of the total items at DESC. Because of the sample stratification, a set of multiplication factors are used by DESC to scale simulation results using this sample to results which are representative of the entire set of DESC inventory items. In this thesis, no attempt is made to scale results obtained through simulation of the sample items to results which

would be representative of demand and item migration for all DESC inventory items.

The techniques for grouping data, fitting distributions to the data, and simulating demand using the hypothesized distributions employed in this thesis are general enough to be applied to other inventory systems where migration among management categories is a problem.

Direction

The direction taken in this effort was to model demand and migration by grouping inventory items according to similar characteristics. The current demand inputs used in the DESC simulation are based on individual demand distributions for each item. The expected gain from using distributions based on a group of inventory items as opposed to separate items is the ability of an item's demand input characteristics to change over time. The change would occur by allowing an item to migrate among the groups as the simulation progresses.

This process more closely follows the actual demand patterns seen at DESC. Many items in the DESC inventory do not receive constant rates of demand. Rather, demand for many items will fluctuate over time. There are many reasons for demand rate changes. The demand for an individual item is often the sum of many user's demand. A change in any user's demand affects the overall demand experienced at DESC. Reasons for changing demand include: changing failure

rates over the lifetime of an electronic component, changing usage rates for weapon systems, weapon system modernization, substitution of one item for another, and customer behavior.

Non-recurring demand can also cause an item's demand pattern to change. Demand is identified in the DESC inventory system as either recurring or non-recurring. Recurring demand is periodic or repetitive in nature. Non-recurring demand, in contrast, is a one-time occurrence (9:A6.1-A6.2). Non-recurring demand can alter a normally stable demand pattern.

The demand for many inventory items is not constant. Therefore, modeling demand using a single distribution which does not change over time seems less than ideal. By allowing an item to migrate among groups with the associated change in the input distribution of the item it is hoped that actual inventory item demand is more closely modeled.

Overview

Chapter II contains an analysis of the migration problem. In addition, the general approach taken in this research is outlined and assumptions are discussed. Finally, a discussion of the simulation model input development process is presented.

Chapter III provides a detailed look at the data collection effort which was accomplished. Inventory item sample composition, types of data collected, and time frame

of the data collection effort are summarized. The actual migration present within the sample of inventory items is compared to total system migration and reasons for differences are discussed. Finally, the item characteristics used in developing item groupings are defined and the distribution of each item characteristic within the item sample is presented.

Chapter IV describes the computer programs developed to accomplish four tasks involved in this effort. First, the program used to define the groupings is described. Second, a description of the program used to collect data based on the item groupings is given. Third, the program used for probability distribution parameter estimation and goodness-of-fit testing is described. Finally, the simulation model is presented along with the measures used to evaluate each item grouping.

Chapter V gives the results for each item grouping tested. The groupings are defined, data collection and distribution fitting results are summarized, and the simulation results are given.

Finally, in Chapter VI, results are summarized and conclusions are drawn about the use of item groupings to model demand and migration. Recommended areas of future study are also given.

II. METHODOLOGY

Introduction

The first section of this chapter reviews previous studies of item migration at DESC. Both the extent and causes of migration are revealed. Following this review, the general approach taken to the simulation of item migration is outlined. Finally, the process of developing simulation input distributions is discussed.

Migration Studies

Before detailing the methodology to be used in this research a review of past migration studies is necessary. The first study into inventory item migration at DESC looked at the extent and causes of migration. A follow-on study attempted to model the migration process as a Markov chain. These studies provide insight into the migration problem and identify the need to include migration when simulating demand for DESC inventory items.

Smith and Gumbert accomplished the first in-depth study of migration at DESC. They calculated migration using data on all Replenishment and Numeric Stockage Objective inventory items from March 1976 to March 1980 (24:2). Their migration counts are shown in Table 2.1.

Table 2.1

TOTAL ITEM MIGRATION (MAR 76 TO MAR 80)

From	RH2	RH1	To RM	RL	NSO	OUT	Total From
RH2		8148	654	56	162	503	9521
RH1	8130		26444	718	1136	881	37309
RM	1281	25889		106641	21556	5312	160679
RL	159	1172	93425		170838	22765	288359
NSO	658	2900	34786	117262		237213	392819
OUT	1090	2700	16882	40097	182230		242999
Total Into	11318	40807	172191	375922	375922	266674	1131686

(Source: Adapted from 24:2)

Table 2.1 shows that a large amount of migration is taking place. In order to determine the causes of migration, a random sample of 204 items was subjected to an in-depth analysis. The results are shown in Table 2.2.

Table 2.2

Causes of Item Migration

Cause	Percent
Demand Changes Only	81.4
Demand/Price Changes	14.2
Price Changes Only	3.4
Other	1.0

(Source: Adapted from 24:2)

Two conclusions of this study are of special interest. First, the DESC inventory management system does not operate

under static conditions. Rather, the movement of items among demand categories results in a dynamic and challenging management environment. Second, simulation models used to evaluate the DESC system need to incorporate item migration in order to better reflect the actual operating environment (25:59).

A second study into item migration was done by Capt Jeffrey J. Hobson, USAF, and Capt Ronald A. Kirchoff, USAF (14). They attempted to model the migration of items as a Markov chain. Their one-step transition matrix included five states. The first four states were the four Replenishment item categories (see Table 1.1). The fifth state was given the name 'OUT' and included all other items. The time frame for each transition was defined to be one quarter (14:46).

They tested the estimated transition matrix against the transition matrix for each quarter to determine if the process was stationary. This test resulted in rejection of the stationary transition matrix hypothesis. Their next approach was to develop transition matrices using, as states, the length of time an item had been in a category. They found that the transition probabilities change for each extra quarter the item stays in the category up to the two year point (14:64). Because of the large number of states in the time dependent transition matrices they did not proceed with this approach (14:65).

The next step in their analysis was to divide the inventory items into stable and non-stable groups according to the number of quarters they had remained in a demand category. They used eight quarters as the dividing point between stable and non-stable items and tested for stationary transition matrices. The hypothesis of stationary transition matrices was again rejected (14:65-66).

One result of Kirchoff and Hobson's effort is increased knowledge of the migration process. In addition, their work identified the time dependent nature of item migration at DESC. In their concluding remarks they reinforce the need for the inclusion of migration in DESC simulation efforts (14:80-81) first identified by Smith and Gumbert (25:59).

The main cause of item migration is changing demand (24:2). Demand for inventory items is a function of both the number of orders (requisitions) received and the quantity demanded per order (requisition size). Changing demand can be caused by changing requisition frequency (requisitions per time period), by changing requisition size, or by a combination of changing size and frequency.

In order to include migration in a simulation model, the input distributions from which demand is generated must change. Changing the requisition frequency and/or requisition size inputs to the model results in simulated item migration.

General Approach

The approach taken to the problem of simulating item migration consists of first collecting data for a sample of DESC inventory items. The next step is to group the items according to common characteristics. Then, historical requisition size and frequency data for each item is collected and identified with the item's group. Next, input distributions for each group of items are determined using this data. The final step is to simulate demand for the sample of items using the input distributions. Simulation results are compared to actual demand and item migration for the sample items.

The sample consists of 40,909 DESC inventory items. The sample is a combination of two samples used in previous DESC simulation studies. The composition of demand categories and item characteristics for the overall sample are detailed in Chapter III.

Grouping of the sample items is accomplished by first identifying a subset of eleven possible item characteristics which define the groups. Next, from 2 to 100 intervals are identified for each item characteristic in the subset. As an example, if item price is chosen as a grouping characteristic, then a set of price levels is input to define the classes of item price. Let X represent item price and P1, P2, and P3 represent three price levels. The resulting item groups are defined as shown in Table 2.3.

Table 2.3

Example Item Grouping

Group #	Characteristic level
1	$X \leq P1$
2	$P1 < X \leq P2$
3	$P2 < X \leq P3$

Each item must fall into one of the three groups. Therefore, P3 must be greater than or equal to the price of the most costly sample item. The number of item characteristics and the associated levels of each characteristic determine the total number of item groups. For instance, if two characteristics are chosen, each with two different levels, the total number of item groups is four. Data are collected by determining group membership for each item in each period for which complete data are available. The results of this process are three empirical distributions for each group: requisition size, requisition frequency, and daily demand. Theoretical probability distributions are fit to the three empirical data sets for each group and goodness-of-fit is determined. The distributions providing the best fit to the empirical data sets are used as input to the simulation model.

The simulation model is designed to approximate the demand generation portion of the DESC inventory system simulation. Four measures are calculated for each quarter of the simulation period after one full year of simulated demand is generated. The first measure is demand category

migration. In the second measure, three values: demand quantity, demand frequency, and demand value are summed for each of six item demand categories: Non-stocked, Numeric Stockage Objective; and Replenishment/Low, Medium, High 1, and High 2. In the third measure, the same three quantities are used. However, for this case they are summed across Federal Stock Class codes rather than item demand categories. Finally, the fourth measure is a count of the number of items in each of five frequency classes. The frequency range for each class is shown in Table 2.4.

Table 2.4

Item Frequency Classes

Class Number	Frequency Range
1	0
2	1 - 9
3	10 - 19
4	20 - 199
5	200 - Above

Comparison of simulation results to actual data across these four measures determines how well demand and item migration are being modeled.

In addition to the four measures described above, simulation output also includes random variate generation statistics. The total number of variates generated, minimum value, maximum value, and average value are calculated for each input distribution. These results are used to verify the input generation process within the simulation model.

Assumptions

The general approach described above relies on three basic assumptions. The first assumption is that the sample of inventory items is representative of the entire DESC item population. Insights regarding this assumption are included in the sample migration analysis in Chapter III. The second assumption is that migration can be modeled without explicit use of a time factor. Past studies reveal the time dependent nature of demand category migration. The approach used in this thesis does not include an explicit time factor when modeling migration. The final assumption is that item migration is defined as in past migration studies. Both Smith and Gumbert (24,25) and Kirchoff and Hobson (14) define migration as the movement of items from one DESC demand category to another over the period of one quarter. Alternative definitions using a different number of demand categories, an alternative grouping based on some other item characteristic, a different time period, or some combination of these alternatives may be more descriptive of the actual process and/or of more use in attempting to simulate item migration.

Simulation Inputs

One of the first tasks in the simulation of a real system is data collection and analysis. This task provides the distributions used in generating simulation inputs. The importance of data collection and analysis is emphasized in

the following thoughts of Banks and Carson (2:333-334).

> "Even if the model structure is valid, if the input data are inaccurately collected, inappropriately analyzed, or not representative of the environment, the simulation output data will be misleading and possibly damaging or costly when used for policy and decision making."

A common method of input data analysis follows four main steps. First, the data are depicted in a histogram plot. Next, the shape of the histogram is used to hypothesize a theoretical probability density function or probability mass function depending on whether the data are continuous or discrete. Estimation of the parameters of the hypothesized distribution and goodness-of-fit testing comprise the last two steps.

Histogram plotting reveals the shape of the empirical density or mass function. The number of class intervals to use in the histogram depends on the number of sample observations and on the amount of dispersion in the data (2:336). A recommended guideline for the number of class intervals is between 5 and 20 (22:46;23:71-72).

Given an idea of the distribution shape provided by a histogram plot, the second step is hypothesis of a theoretical distribution. This step requires knowledge of the available theoretical probability density and mass functions and the shapes they can take on. Law and Kelton (16) and Bratley, Fox and Schrage (6) provide distribution specific information and graphic depiction of commonly used theoretical distributions. In addition, Law and Kelton also

provide a list of potential applications for the various distributions (16:158-175). For example, they cite the "number of items demanded from an inventory" as a possible application of both the Geometric and Poisson probability mass functions (16:171,175).

Once a specific distribution has been hypothesized, the next step is estimation of the distribution parameter(s). The method of moments and the method of maximum likelihood are two frequently employed parameter estimation techniques. The method of moments involves equating the kth moment of a random variable with the corresponding kth sample moment. The kth moment of a random variable is defined as $u_k = E(X^k)$, where E is the expectation operator (3:142;21:357). The kth sample moment is the average $m_k = (1/n) \sum Y^k$, where n is the number of sample observations (21:357). The estimated parameters are the solutions to the equations $u_k = m_k$ for each moment k up to the number of parameters (21:357). Advantages of this method include ease of application and the fact that it provides consistent estimators. A disadvantage is that the "estimators derived by this method are not functions of minimally sufficient statistics and hence are not very efficient" (21:360). Also, estimators developed using the method of moments are often biased (21:294,360).

The method of maximum likelihood involves finding estimates to distribution parameters so that the function

$L(y_1,y_2,...,y_n)$ is maximized. Here, $L(y_1,y_2,...,y_n)$ is the joint probability associated with the observed data (21:347,362). Mendenhall, Scheaffer, and Wackerly provide several examples of how this technique is applied to specific theoretical distributions (21:362-365). One difficulty with this method is the need for numerical approximation techniques when the system of equations resulting from the likelihood function cannot be solved directly (5:34). An advantage is the desirable properties associated with parameter estimates obtained using this method (5:34-35;21:365).

The two parameter estimation techniques described above are not the only available methods. Other techniques include the method of least squares, minimum chi-square method, Baynesian statistics, and probability plotting. A discussion of these and other techniques is given in "An Application of the H-Function to Curve-Fitting and Density Estimation" by Carl D. Bodenschatz and Ralph A. Boedigheimer (5:27-39).

Once distribution parameters have been estimated, the next step is to perform a goodness-of-fit test. The basic idea in goodness-of-fit testing is to compare the empirical density function to the density function of the hypothesized distribution. Two widely used goodness-of-fit tests are the chi-square and Kolmogorov-Smirnov tests (2:350-358;11:58-61; 15:192-204).

The chi-square test is used to perform goodness-of-fit tests for both discrete and continuous distributions. In this test, the n sample observations are divided into a set of k class intervals (cells). The test statistic is calculated as: (2:350)

$$X_0^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \qquad (1)$$

where O_i is the number of sample data observed in the ith cell

E_i is the expected number in the ith cell

$E_i = np_i$ where p_i is the probability associated with with the ith cell of the hypothesized distribution

The null hypothesis (H_o) is that the sample data conform to the hypothesized distribution. The critical value for the test is X^2(alpha,k-s-1) where alpha is the probability of a Type I error (rejecting H_o when H_o is true) (21:378), k is the number of cells, and s is the number of parameters estimated from the data (2:350). Rejection of the null hypothesis occurs if $X_0^2 > X^2$(alpha,k-s-1).

Decisions to be made in applying the chi-square test include the number of cells to use and the range of values in each cell. Banks and Carson (2) give guidelines for establishing the number of cells. They suggest between 5 and 10 cells when the number of observations is between 50 and 100, and between $n^{1/2}$ and n/5 when the number of observations exceeds 100 (2:351). In addition, they suggest not using the chi-square test for sample sizes of 20 or

less. The rule for establishing cell boundaries is equal or nearly equal probability within each cell (2:350;15:196). Another consideration which can affect both the number of cells and the cell boundaries used is that expected cell frequencies should be greater than or equal to 5 (2:350;15:197;23:76). Finally, when testing a discrete distribution, "each value of the random variable should be a class interval, unless it is necessary to combine adjacent class intervals" (2:351).

The advantage of the chi-square test is that it can be applied to any distribution with any number of parameters estimated from the sample data (2:357). One disadvantage is the need for a large number of sample observations. Another disadvantage stems from the flexibility available for defining the number of cells and cell intervals. The problem is that alternative tests of the same sample data using a different number of cells or different cell intervals can result in conflicting test results (2:357; 15:197).

Another goodness-of-fit test is the Kolmogorov-Smirnov (KS) test. In this test the empirical distribution is compared to the theoretical distribution to obtain a maximum deviation. Two comparisons are made at each of n sample observations: (15:200)

$$D_n^+ = \max_{1 \leq i \leq n} \{(i/n) - F(X_{(i)})\} \quad (2)$$

$$D_n^- = \max_{1 \leq i \leq n} \{F(X_{(i)}) - (i-1)\} \quad (3)$$

where $X_{(i)}$ is the ith smallest sample value

$F(X_{(i)})$ is the value of the hypothesized cumulative density function at $X_{(i)}$

The maximum deviation (D_n) is obtained by letting $D_n = \max\{D_n^+, D_n^-\}$ (15:200). D_n is compared to the critical value at a specified probability of Type I error (alpha level). If the maximum deviation exceeds the critical value, the null hypothesis is rejected (15:199-201).

One disadvantage of the KS test is that it is biased when parameters have been estimated from the data. This disadvantage has been overcome for a small number of theoretical distributions through the use of adjusted KS statistics (15:201-202). Lilliefors, through simulation, found adjusted KS test critical values for the normal distribution with estimated mean and variance (17:400). He also found adjusted KS test values for the exponential distribution when estimating the parameter from the sample mean (18:387-388). Littel, McClave, and Offen (19) found adjusted values for the Weibull distribution with estimated shape and scale parameters. Another disadvantage is that the KS test is only applicable for testing hypotheses regarding continuous theoretical distributions.

Massey (20) offers three advantages of the KS test over

the chi-square test. First, he shows how a lower bound on the power of the KS test can be found, where, "in general, the power of the chi-square test is not known" (20:76). The second advantage is that the KS test can be used for very small samples while the chi-square test cannot. The third advantage he gives is that the KS test takes less computation than the chi-square test (20:76).

Summary

This chapter reviewed the DESC migration studies showing the extent and causes of inventory item migration. In addition, the general approach taken to simulation of item migration was outlined. The final section on development of simulation inputs provides a background into the steps in this process and commonly used techniques for accomplishing these steps. The next chapter gives a detailed description and preliminary analysis of the sample data.

III. DATA COLLECTION

Introduction

This chapter defines the sample of inventory items and the composition of the sample over time. A comparison of sample migration to actual migration is given including a discussion of reasons for the differences. After the sample has been defined, the next section describes the raw data collected from two DESC data sources. Finally, the item characteristics developed from the raw data are defined and the distribution of each item characteristic within the sample is summarized.

Collection Timeframe

The data collection effort is divided into two time periods. The first period, referred to as the "data analysis period", is from October of 1978 to December of 1981. The second period, referred to as the "simulation period", is from January of 1982 to June of 1985. Data from the data analysis period is used to develop the simulation inputs while data from the simulation period is used to compare simulated results against actual DESC demand and item migration.

Sample

The sample consists of 40,909 DESC inventory items. These items are from two separate samples created for past DESC simulation efforts. The first sub-sample is a set of

7,138 Replenishment items. The remaining 33,771 items are from a sample of Numeric Stockage Objective items.

Sample Composition. The number of sample items in each DESC management category changes over time. The changes are due to item migration. The effects of item migration on sample composition is illustrated in Table 3.1. The figures in Table 3.1 represent the number of items in six management categories at the start of each year of the overall data collection timeframe.

Table 3.1

Changing Sample Composition

Year	Non-Stocked	NSO	Replenishment Categories Low	Medium	High1	High2
*79	4672	30016	3466	1354	623	778
80	1232	35759	1460	991	653	814
81	6869	28228	2737	1487	617	971
**82	6018	27812	3255	1846	794	1184
83	7549	25791	3536	1847	685	1501
84	9624	23204	3864	1931	764	1522
85	10945	21959	3724	2123	784	1374

*Years 79 through 81 represent the data analysis period.
**Years 82 through 85 represent the simulation period.

Sample Migration. The data in Table 3.1 suggest extensive migration of sample items within management categories over the seven years for which data were collected. Because the timeframe of the Smith and Gumbert migration study overlaps a portion of the data collection timeframe in this research, it is possible to compare the total system migration figures of Smith and Gumbert to the

sample migration. Table 3.2 contains one such comparison for migration between the first and second quarters of 1979. The figures shown represent the percentage of items that started in a given category and ended up in each of the six categories.

Table 3.2

Total System Versus Sample Item Migration

From	To: Non-Stocked	NSO	Replenishment: Low	Medium	High1	High2
Non-Stocked	70.38	27.93	0.71	0.37	0.28	0.34
Total	92.17	6.44	0.87	0.41	0.08	0.04
NSO	0.03	99.57	0.28	0.11	0.02	0.01
Total	0.51	97.78	1.25	0.41	0.04	0.01
R/Low	0.09	14.22	83.12	2.54	0.00	0.03
Total	0.88	5.09	89.97	4.04	0.03	0.00
R/Medium	0.22	5.32	14.11	76.07	3.99	0.30
Total	0.99	1.66	11.32	83.34	2.61	0.08
R/High1	0.64	0.48	0.00	8.83	80.74	9.31
Total	1.17	0.41	0.20	18.21	75.20	4.81
R/High2	0.77	0.00	0.13	0.00	8.23	90.87
Total	1.05	0.06	0.03	0.53	14.39	83.95

The large differences between total system and sample migration seen in some figures of Table 3.2 are due to two factors. First, the sample items had to be established items (minimum of two years in the DESC system) in order to be picked in the original samples. In contrast, the total inventory items at DESC contain some relatively new items which have not been in the system for two years (1). A

second possible explanation for the differences in Table 3.2 is the sample stratification used in picking Replenishment sample items.

In stratified sampling, the distribution to be sampled is divided into portions called strata (13:660). Each of the strata is sampled in different proportions to obtain more observations from the critical areas of the distribution. The strata used by DESC are the four Replenishment categories: Low, Medium, High 1, and High 2 (4). In addition, sub-strata are also defined within the four Replenishment categories. The sub-strata are based on levels of annual demand value within the categories (4). The result of the stratification scheme is a disproportionately heavy sample of items with high annual demand value. As an example, as of the first quarter of 1985, there were a total of 159,639 Replenishment items at DESC with 21,764 being High 1 or High 2 (8:26). The sample of 40,909 items, as of the same time, contains 7,708 Replenishment items of which 2,148 are High 1 or High 2. Therefore, the sample contains over twice as many High 1 and High 2 items (27.9% versus 13.6%) than would be expected using normal random sampling techniques.

The requirement for established sample items coupled with the sample stratification results in sample migration figures which are not representative of total migration at DESC. For this reason, simulated migration is compared to

sample migration only, rather than comparing to both sample migration and total system migration.

Data Collected

Two types of data were collected on the sample items, detailed demand data and item management data. The source of detailed demand data is the Requisition History tapes maintained by DESC. These tapes contain information on every requisition which occurred for DESC inventory items since October of 1977. The source of item management data is the DESC Fractionation tapes. These tapes contain demand summary data, item price, and management category data for each item in the DESC system. Fractionation data are available for each quarter since the first quarter of 1976.

Requisition History Data. The Requisition History database maintained by DESC contains information on every requisition which occurred for each inventory item. These files are divided into monthly segments with the data for each month contained on individual magnetic tape volumes. Five pieces of information were collected on each requisition in the data base from October of 1978 to December of 1981. The five pieces of information are Item Stock Number (ISN), requisition quantity, date of requisition, requisition type, and requisition priority.

The ISN identifies which DESC inventory item was requisitioned. Quantity is the number of items demanded, and date of requisition is the Julian calendar date on which

the requisition was received. Requisition type pertains to the origination of the requisition. Two types are possible, normal requisitions and foreign military requisitions. Foreign military requisitions are further broken down into Foreign Military Sales (FMS) and Military Assistance Program (MAP)/Grant-Aid requisitions. The final data element is requisition priority. Priority ranges from 1 to 15. The levels are divided into groups called Issue Priority Groups (IPGs). Priority levels 1 through 3 are IPG I; 4 through 8 are IPG II; and 9 through 15 are IPG III. The IPG and the date of requisitions determine an item's release pattern (12).

The collection of Requisition History data involves three steps. First, the tape for a given month is sorted in ascending ISN order. Next, the sorted tape is compared, record by record, with the sample item data tape and all entries with matching ISNs are retrieved and saved on a separate tape. The first two steps were repeated for each of the 39 months in the data analysis period. Finally, the last step was to merge all tapes containing monthly matches into one large data file. This collection effort is summarized in Table 3.3. The end result is a tape containing a total of 799,388 requisitions for the 40,909 sample items during the data analysis period.

Table 3.3

Requisition History Data Collection Results

Year	Month	Total Record Count	Matched Record Count
1978	Oct	336642	16727
	Nov	339008	16462
	Dec	325916	18123
1979	Jan	345791	20515
	Feb	346148	16582
	Mar	369684	19288
	Apr	339875	16822
	May	352857	18117
	Jun	314681	16347
	Jul	------	-----
	Aug	315748	21727
	Sep	332504	22759
	Oct	348155	23118
	Nov	310252	22072
	Dec	309891	21834
1980	Jan	359257	19246
	Feb	338990	22654
	Mar	389918	23779
	Apr	351658	24483
	May	346394	24635
	Jun	369091	23457
	Jul	364905	27235
	Aug	352158	26085
	Sep	367390	24832
	Oct	363400	22921
	Nov	333056	20761
	Dec	------	-----
1981	Jan	359401	19704
	Feb	336518	20892
	Mar	380102	25637
	Apr	378291	27358
	May	346022	25231
	Jun	345546	25959
	Jul	355132	25220
	Aug	341135	24581
	Sep	354412	25717
	Oct	385793	23555
	Nov	------	-----
	Dec	349860	24953
	Total	12555581	799388

Table 3.3 identifies three months for which data could not be collected: July 1979, December 1980, and November 1981. The July 1979 data tape contained only half the normal number of requisitions and half the normal number of matches. The only explanation for the unusually small number of requisitions on this tape is that an error must have occurred when creating the tape. The backup tape gave exactly the same results. Therefore, data for July 1979 were excluded from the sample data base. The December 1980 and November 1981 data could not be included because of bad magnetic tape. Neither the original nor the backup tape files for these months could be read.

Fractionation Data. The DESC Fractionation files contain item demand and management data for each item on a quarterly basis. Elements of this data which were collected include: annual demand frequency, annual demand quantity, annual demand value, item price, and several management codes from which demand category could be determined. Fractionation data were collected for both the data analysis period and the simulation period.

The Fractionation data collection process was much the same as that for Requisition History data. One difference is that Fractionation records are already in ascending ISN sequence so that no sorting of these files is necessary. The results of this data collection are given in Table 3.4.

Table 3.4

Fractionation Data Collection Summary

Year	Quarter	Total Record Count	Matched Record Count
1978	Oct-Dec	496493	36044
1979	Jan-Mar	708232	38012
	Apr-Jun	514940	37722
	Jul-Sep	669501	36572
	Oct-Dec	499362	39328
1980	Jan-Mar	719102	40107
	Apr-Jun	------	-----
	Jul-Sep	709219	38438
	Oct-Dec	475609	35084
1981	Jan-Mar	651001	34917
	Apr-Jun	483420	34215
	Jul-Sep	721275	37768
	Oct-Dec	516439	35088
1982	Jan-Mar	729995	37380
	Apr-Jun	556549	34710
	Jul-Sep	784869	37227
	Oct-Dec	563378	31690
1983	Jan-Mar	777593	35879
	Apr-Jun	579083	32486
	Jul-Sep	784869	35277
	Oct-Dec	585073	31690
1984	Jan-Mar	788707	34470
	Apr-Jun	601766	31165
	Jul-Sep	831842	35025
	Oct-Dec	609002	30048
1985	Jan-Mar	845140	34544
	Apr-Jun	621086	29896

Two observations are apparent from Table 3.4. First, Fractionation data for the second quarter of 1980 does not exist. The reason for the missing data is again bad data tapes. The original tape for April through June of 1980 is unreadable and the backup tape is missing. An attempt was

made to read another data source, called the Edited Fractionation file, as a replacement for this data. However, the Edited Fractionation file for the second quarter of 1980 does not contain correct data, instead it was created using the Fractionation file for July through September of 1980.

The second observation apparent in the data of Table 3.4 is that tapes for the second and fourth quarters of each year contain far less entries than the other quarters. The reason is that Non-stocked items are included in the Fractionation files only in the first and third quarters of each year. As a result, data for Non-stocked items is not available for 2 of every 4 quarters.

Appendix A describes the record layout and tape format for both Fractionation and Requisition History data files. In addition, descriptions for the five main working files created from the Fractionation and Requisition History data files are also given.

Item characteristics

The data collection effort created a large database from which 11 item characteristics were developed. The eleven characteristics are defined below:

1) Annual Demand Frequency - the number of requisitions which occured for an item over one year. This characteristic is taken from the Fractionation data.

2) Item Demand Category - one of six DESC management categories as defined previously. The categories were coded as follows: Non-stocked = 1, NSO = 2, Replenishment/Low = 3, Replenishment/Medium = 4, Replenishment/High 1 = 5, and

Replenishment/High 2 = 6. This characteristic is determined from elements of the Fractionation data.

3) Maximum Requisition Size - the largest quantity demanded in any one requisition over the period of one quarter.

4) Average Requisition Size - the mean of all requisition quantities over one quarter.

5) Demand Category Stability - the number of consecutive quarters an item has remained in it's current demand category.

6) Average Requisition Priority - the mean of all requisition priorities for an item over one quarter. Priority is coded as follows: IPG I = 1, IPG II = 2, and IPG III = 3.

7) Average Requisition Type - the mean of all requisition types for an item over one quarter. Type is codes as follows: normal = 0, MAP/Grant-Aid = 1, and FMS = 2.

8) Item Price - the price of the item determined from the Fractionation files.

9) Annual Demand Quantity - the number of items which were demanded over a one year period. This comes from the Fractionation data.

10) Federal Supply Class - each item comes from one of 70 descriptive item classes. For example, Resistors, and Automated Data Processing Supplies make up two of the 70 classes (8:5).

11) Annual Demand Value - the total dollar value of demand for an item over a one year period. This quantity is determined by taking the product of price and annual demand quantity from the Fractionation files.

These 11 item characteristics were used to define item groupings for simulation input development and simulation of demand and item migration. The distributions of these 11 characteristics within the sample as of the third quarter of 1981 are given in Appendix B.

Summary

This chapter provided a description of the item sample used in the research along with the composition of DESC management categories and item migration within the sample. In addition, the data collection effort was summarized and the resulting item characteristic database was defined. In the next chapter, the four main programs used to obtain results are described.

IV. PROGRAM DEVELOPMENT

Introduction

The amount of raw data necessitates an automated approach to grouping the items, developing simulation inputs for the different groups, and simulating inventory item demand. This chapter describes four FORTRAN programs written to accomplish these tasks. The purpose of each program is outlined and program input and output requirements are reviewed.

All programs were developed on a VAX/VMS computer system using standard FORTRAN 77. Therefore, the programs should be transportable to other computer systems with a minimum of programming effort.

Group Definition

The first step in the process of testing different item groupings is to define the groups. The item groups are defined by identifying the item characteristics (e.g., demand category, item price, etc.) to be used and a set of levels (e.g., for price: $2, $20, $200, and above) for each characteristic. The resulting grouping definition is saved on a disk file for use in the three subsequent programs. The purpose of the first program is to accomplish these tasks. The source code for this program is given in Appendix B.

Program Input. Input to this program includes a title for the grouping, the time-frame of data collection,

and the item characteristics which define the item groups. A single grouping can use all eleven item characteristics with up to 100 levels each. However, the total number of groups is limited to 1000.

Program Output. Once the item groups are defined, the program saves all information on a disk file. In addition to the grouping definition file, the program also outputs a file of item characteristic levels for each grouping. The file is ordered sequentially with the first record being the characteristic levels of the first group.

Data Gathering

Once an item grouping is defined, the actual data collection is accomplished. A second FORTRAN program does the data gathering task. The source code for this program is also given in Appendix C. Input to the program includes the files output by the grouping definition program and the DESC Requisition History and Fractionation file data. Output includes both a summary of program results and empirical data files for use in developing simulation input distributions.

The purpose of this program is to gather three empirical data distributions for each group. Each inventory item is identified with one group according to the item's characteristics. Three types of data are gathered for each item. The first type of data is daily demand quantity. Daily demand quantity is obtained by summing all

requisitions for an item which occur on a single day. The total quantity for days with positive requisition quantity is saved on the group's empirical demand quantity data file. The second type of data collected is requisition size. The quantity of each requisition for an item is saved on the group's empirical requisition size data file. The final type of data is requisition inter-arrival time. Inter-arrival time is the number of days between consecutive requisitions for the item. These observations are saved on the group's empirical inter-arrival data file.

Program Input. Data gathering program input comes from several sources. Group definitions and the group characteristic levels are read from the files created by the first program. Item characteristic data are obtained from four sources.

The first source is the item identification file which contains file control information for reading the Requisition History and Fractionation data. Each record of this file corresponds to one sample item. The record content includes the item's FSC code (item characteristic number ten), the number of requisition history entries for the item, and the number of Fractionation entries for the item.

The second source of data for individual sample items is the demand category file. The records of this file contain 12 demand category values: one for each quarter in

the data analysis period. Each record contains data for one sample item. These data are the source of item characteristics two (Demand Category) and five (Demand Category Stability Factor).

The third source of individual item data is the Requisition History file. The requisitions (if any were collected) for each item are read from a sequential tape file. Requisition History data are the source of item characteristics three (Maximum Requisition Size), four (Average Requisition Size), six (Average Requisition Priority), and seven (Average Requisition Type).

Fractionation data are the final source of individual item characteristics. The quarterly entries (if any were collected) for each item are used as the source of item characteristics one (Annual Demand Frequency), eight (Item Price), nine (Annual Demand Quantity), and eleven (Annual Demand Value).

Program Output. The first program output is a summary of data collection counts for three empirical distributions for each item group. Data storage array size is limited to 200,000 observations. Therefore, the empirical data must be saved on a disk file after every 200,000 observations have been collected. At every save, the program outputs the current and total observation count for each group and for each of the three empirical distributions. The final observation count depends on the

number of groups used; however, it is usually about 1.5 million observations. This number of observations requires seven intermediate data saves.

The discrete nature of all three empirical data types allows the data to be saved in the form of observation counts. Each discrete value which is observed has an associated observation count. This method results in a large savings in total disk space usage for each grouping. If actual observations were saved the disk space requirement would be approximately 6.5 megabytes. By saving only observation counts, the disk space requirement drops to between 0.1 and 0.5 megabytes depending on the number of item groups.

In addition to the empirical data files, the program also writes three files for use in the simulation program. The first file contains probabilities for requisition priority, requisition type, and positive daily demand for each group. Requisition priority probabilities are calculated by saving counts of the number of requisitions in each Issue Priority Group. Each count is divided by the total number of observations to determine requisition priority probabilities in each group. Requisition type probabilities are calculated by saving counts of the number of normal, FMS, and MAP/Grant-Aid requisitions and again dividing by the total observations. Daily demand probability is calculated by dividing the number of positive

days of daily demand by the total possible days of daily demand.

The second output file for use in the simulation contains the group in which each item starts the simulation. This is the group to which the item belonged in the last quarter of the data analysis period. Each item's group number is written to a separate record in the output file.

The third output file contains a count of the number of items in each group as of the start of the simulation. This count is also obtained from the item groups in the last quarter of the data analysis period.

Distribution Fitting

The third step in the process of testing alternative item groupings is to develop simulation input distributions from the empirical data. A third FORTRAN program was written to accomplish this step. The source code for this program is also given in Appendix C. The objective of this program is to find a good representation of item demand to use within the simulation. Several continuous and discrete theoretical distributions are compared.

Determination of the distributions to be used in the simulation model involves a two step process. The initial step identifies the best fitting continuous and discrete distributions. A relative comparison of Chi-square test statistics determines the best distributions. In the final

step a subjective comparison is made of these two distributions. This comparison emphasizes how well the best continuous and discrete theoretical distributions fit the tails of the empirical distribution. If one of the theoretical distributions provides a reasonable fit to the empirical data then it is used in the simulation model. The alternative is to use the empirical distribution.

The four continuous distributions tested are the Exponential, Gamma, Weibull, and Uniform. A separate test of the Exponential distribution is done because random variate generation for this distribution is faster than Gamma or Weibull variate generation. The Exponential is a special case of both the Gamma and the Weibull distributions. However, parameter estimation for the Gamma and Weibull distributions would rarely result in shape parameters of exactly 1.0 (the Exponential case).

The discrete nature of the empirical distributions causes difficulties in applying goodness-of-fit tests for continuous distributions. The difficulty with the Kolmogorov-Smirnov test is that the value of the hypothesized cumulative density function (cdf) is exactly the same for every observation at a single integer value. However, these cdf values are compared to cumulative order statistic probabilities along the entire continuous range from 0.0 to 1.0. The result is rejection of the null hypothesis regardless of how well the hypothesized cdf

conforms at the discrete values.

In the Chi-Square test a problem arises from the desire for equal probability within the test cells. Most of the DESC empirical distributions have a high probability associated with the first observed value (one for the daily demand and requisition size distributions and zero for the inter-arrival distributions). The high number of empirical observations suggests a large number of cells according to common guidelines. For example, given an empirical distribution with 400 observations, a suggested minimum number of Chi-Square test cells is 20 (2:351). The resulting probability within each test cell is 0.05. However, the range of hypothesized distribution values in the first cell would often not include the first observed empirical value since the probability of this value is 0.10 or greater. The resulting test statistic is extremely large (expected number of observations equal to 20 versus empirical observations of 0) and results in immediate rejection of the null hypothesis.

Dropping the number of test cells is one cure for this problem; however, a very low number of cells is often necessary to insure a positive number of empirical observations within each cell. The low number of cells results in gross aggregation of the empirical data and an unrealistic test. For example, with 1,000 empirical observations and an empirical probability of 0.15 associated

with the first observed value, to include the first observed empirical value in the first test cell requires a cell probability of greater than 0.15. The resulting number of cells is six. This level of data aggregation does not provide a good test of how well the theoretical distribution compares with the empirical data.

Another possibility is to ignore the need for equal probabilities within the test cells. This method is used to provide a relative comparison among the distributions. The test compares the probability of each observed empirical data value to the hypothesized continuous distribution. The test employs information on how the continuous random variates will be used within the simulation model. Within the simulation model, the fractional portion of a continuous variate is truncated. For example, when generating a requisition size variate, the FORTRAN function AINT (10:332) is used to trucate the fractional portion and 1.0 is added to the result. If a value of 0.50 is generated as the random variate the resulting requisition size is 1.0 (AINT(0.50) + 1.0). This process provides a guideline for testing the theoretical continuous distributions against the discrete empirical distributions. The probability of each observed value is compared with the theoretical distribution probability of generating that value. For instance, in the above example, the theoretical probability from 0.0 to 1.0 is compared to the observed probability of a requisition

size of 1.0. These probabilities are multiplied by the total number of observations and the usual Chi-Square test statistic is calculated. The test statistics for all observed values are summed to give an overall goodness-of-fit test result. The resulting test values for each of the four theoretical distributions are compared with the smallest value determining the best fitting distribution. This procedure gives a relative measure for determining the best continuous distribution. However, it is important to emphasize that no statistical confidence can be placed on the result.

The discrete theoretical distributions tested are the Poisson, Geometric, and discrete Uniform. The normal Chi-Square test is applied with the minimum test statistic determining the best fitting distribution. Statistical confidence cannot be attached to these tests since "the statistics associated with tandem goodness-of-fit tests have unknown distributions" (6:123).

Given the best fitting continuous and discrete theoretical distributions, the final decision as to which distribution is used in the simulation model results from a subjective analysis. The two best theoretical distributions identified in the process described above are compared to the empirical distribution at each of the first five and last five observed values. This shows how well the theoretical distributions fit the tails of the empirical

distribution. If the best continuous or discrete theoretical distribution provides a good fit to the tails of the empirical distribution it is used in the simulation model. If neither of these theoretical distributions provides a good fit then the empirical distribution is used.

Program Input. Empirical data files for each of three distributions for each item group are the inputs to this program. The program reads each data value and the associated observation count. The data values are then sorted and the cumulative probability of each value is determined. The resulting empirical data array is used in parameter estimation and goodness-of-fit testing.

Program Output. Output consists of summary statistics, distribution parameters, and goodness-of-fit summary tables. The summary statistics are: minimum, maximum, mean, variance, standard deviation, and number of observations. Parameter estimates for each theoretical distribution are output along with a table summarizing the goodness-of-fit test. For the continous theoretical distributions this table includes the empirical and hypothesized probability and cumulative probability for the first five and last five observed values. For the discrete distributions this table gives the test statistic and expected and observed frequencies for each of the first five and last five cells. In the discrete case cells are

combined to insure that the first and last cells have an expected frequency of at least five.

The resulting distributions are used in the simulation of demand for DESC inventory items. The simulation model is discussed next.

Simulating Demand and Item Migration

The fourth FORTRAN program does the actual simulation of demand and migration. The source code for this program is also included in Appendix C. Input to the program consists of the item grouping definition, input distribution information, and initial simulation values. Output consists of several comparisons of simulation results to actual DESC data.

Simulation Model. The model is designed to represent the demand generation portion of the DESC simulation. Demand for inventory items is simulated using either a daily demand simulation or a next-event simulation. Determination of the type of simulation for each item group is made on the basis of the probability of positive daily demand for that group. A value of 0.12 is used as the discriminant with groups having a probability of positive daily demand below 0.12 being modeled using a next-event simulation. Groups with a probability of positive daily demand greater than or equal to 0.12 are modeled using a daily demand simulation.

The reason for the use of two different simulation types is computer run-time considerations. Generation of

theoretical distribution random variates requires differing amounts of computer time depending on the form of the distribution. The optimal cutoff value between daily demand and next-event type simulations is very dependent on what type of variates are being generated. The value of 0.12 is based on two simplifying assumptions. The first assumption is that generation of a non-uniform variate (i.e., Weibull) requires a uniform variate as in the inverse transform technique (2:294-300). The second assumption concerns the time difference for generation of uniform versus non-uniform variates. Given these assumptions, the probability of positive daily demand at which the length of time required to generate one day of item demand in a daily demand simulation equals the time required to generate one day of item demand in a next-event simulation can be found. Assuming non-uniform variate generation takes five times as long as uniform variate generation the probability of positive daily demand is 0.167. Assuming non-uniform variate generation takes ten times as long as uniform variate generation the probability of positive daily demand is 0.091. A value of 0.12 is used because it lies in between these two limits. However, no attempt is made to find the optimum value.

Daily demand simulation requires a uniform random variate be generated for each day of the simulation. This variate is compared to the groups probability of positive

daily demand. Uniform variates below the groups probability of positive daily demand result in generation of a daily demand quantity variate. Requisition frequency for days with positive demand is obtained by dividing the demand quantity by the average requisition size for that group. The result is rounded to the closest integer value under the restriction of a minimum requisition frequency of one given that positive daily demand has occured.

Next-event simulation requires two input distributions: requisition inter-arrival time and requisition size. Demand generation in this case involves a two step process. First, a sample from the groups inter-arrival time distribution is obtained. Second, the simulation is advanced that number of days and a requisition size variate is generated for the item. Inter-arrival times of zero result in more than one requisition on a given day.

Simulation initial conditions are determined from actual DESC data. An item starts the simulation in whatever group in which it was last observed. The type of smoothing used to generate the forecasted values is set according to an item's last observed annual demand frequency (4). Items with annual demand frequency of 200 and above are smoothed monthly while those below 200 are smoothed quarterly (4). Smoothing factors depend on whether monthly or quarterly forecasting is used. Factors of 0.1 and 0.9 are used with items forecasted monthly and factors of 0.2 and 0.8 are used

with items forecasted quarterly (4). Forecasted annual demand quantity is initialized according to an item's last observed annual demand quantity (4). Initialization using actual data helps to minimize the bias associated with initial simulation results (2:430).

Simulation Input. Model input is required in many forms. All initialization data mentioned above must be read from disk files. In addition, if empirical distributions are used to model demand these distributions must be read from a disk file as the simulation progresses. A final input requirement is the actual DESC demand and migration data.

Simulation Output. The simulation model runs for 14 quarters. Output for each quarter after one full year of demand has been generated includes: annual demand quantity, frequency, and value comparisons; item frequency group counts; and migration comparisons. At the end of the simulation a summary of input distribution statistics is produced to verify the random variate generation process.

Simulated annual demand quantity, frequency, and value are compared to actual DESC data in two formats: by item management categories and by Federal Stock Classes. Demand frequency is also compared by summing the number of items in five frequency groups and comparing to actual DESC data.

Simulated migration is compared to actual migration in several formats. First, a table of the migration counts and

migration percentages is given for migration into each of the six demand categories in each quarter. Second, item stability (consecutive quarters in the same demand category) is compared to actual item stability. Finally, the volatility of item migration is compared to actual migration data. Here, volatility refers to the number of categories an item jumps in one migration. For instance, migration from the Non-stocked (category one) to Replenishment/High 2 (category six) represents the largest possible jump size of five categories.

These comparisons provide an idea of how well the input distributions obtained from a given item grouping model the demand and migration of DESC inventory items. In addition, they also provide insight into how the groupings can be expanded and/or changed to provide a better model of demand and migration.

Summary

This chapter gave a general description of the four main programs used in the analysis of inventory item groupings. Each program's objective, input requirements, and outputs were reviewed. In the next chapter the results obtained from several alternative item groupings are presented.

V. RESULTS

Introduction

This chapter presents the results for each item grouping. The sequence of presentation is: grouping definition, data collection results, distribution fitting results, and simulation results.

First Item Grouping

DESC management categories were chosen as the groups for the first item grouping for two reasons. First, since migration is defined as the movement of items among these management categories, a grouping using the categories seemed logical. The second reason is that management categories provide a simplistic grouping with a small total number of groups and simplifies program testing and data checking. The first grouping is defined in Table 5.1.

Table 5.1

First Item Grouping Definition

Group #	Category
1	Non-stocked
2	NSO
3	Replenishment/Low
4	Replenishment/Medium
5	Replenishment/High 1
6	Replenishment/High 2

Data Collection. Table 5.2 gives the results of the data collection effort. The numbers in the table under the three empirical distribution headings represent total

observation counts. The numbers in the column headed "item count" represent the total number of items in each group as of the last quarter of the data analysis period (July through September of 1981).

Table 5.2

Data Collection Results for the First Item Grouping

Group #	Daily Demand	Requisition Size	Requisition Inter-arrivals	Item Count
1	3591	4131	3118	5828
2	45416	47561	27266	28531
3	31760	35958	28871	3114
4	46459	58370	53700	1654
5	66410	120162	117631	714
6	167199	324388	320861	1068

As can be seen from the data in Table 5.2, a large percentage of the sample requisitions come from the high demand categories. Replenishment/High 1 and High 2 (groups five and six) alone account for over two-thirds of the total requisitions for the sample items. The sample, as mentioned earlier, is weighted toward the high value items because they account for the greatest percentage of stock fund expenditures.

Three additional observations regarding the data collection effort on the first grouping are important. First, this effort identified two errors which occured in the original DESC data collection. The last portion of two consecutive quarters of fractionation data were not collected due to bad tapes. Approximately 3,000 sample

items were affected by this error. Since missing items are assumed to be Non-stocked, the result of this data error was a large number of high demand Non-stocked items in the seventh and eight quarters of the data analysis period. The error is corrected by making an analysis of affected item demand categories before and after the two missing quarters. Affected items with consistent demand category patterns before and after these two quarters are assumed to be stable and their demand categories in the missing quarters are corrected to reflect demand category stability. After this data correction, Non-stocked observations in the affected quarters were consistent with all other quarters.

A second observation regarding the data collection effort for the first group is the obvious disparity between requisition size and requisition inter-arrival period observation counts. Under conditions of perfect data, the number of inter-arrival observations in each group would be one less than the number of requisition size observations. The reason for the differences seen in Table 5.2 is missing quarters of requisition data. Inter-arrival observations spanning missing quarters of requisition data were discarded. Items with only two requisitions during the entire data analysis period are an exception. The number of days between the two requisitions for these items is used as an inter-arrival observation even if the two requisitions

fall on opposite sides of a period of missing data.

The final observation concerns an assumption made in order to model inter-arrivals for groups with very low demand frequency. A large percentage of the items in groups one and two received only one requisition during the data analysis period. No inter-arrival data are available for these items. The assumption of uniform arrivals over a period of 821 days (the number of days in the data analysis period) allowed random inter-arrival observations to be generated for these items. A discrete uniform random number is generated between 1 and 821. This random value is added to the number of days from the date of the single observed requistion to the end of the data analysis period. The resulting quantity is used as the inter-arrival observation for the item. Without this assumption, the simulated demand for items with very low demand frequency was extremely high in comparison to actual DESC data.

Distribution Fitting. The simulation input distributions resulting from the goodness-of-fit analysis are summarized in Table 5.3. Groups with a probability of positive daily demand above 0.12 are modeled using a daily demand simulation while those below are modeled using a next-event simulation.

The term "best" in table 5.3 is relative to the other distributions tested. None of these distributions provide a satisfactory fit to the empirical distributions; therefore

the empirical distributions are used as input to the simulation model. The reason for lack of fit in all cases is high probability in the lower tail of the empirical distribution in addition to a long upper tail.

Table 5.3

Distribution Fitting Results for the First Item Grouping

Group	Type of Simulation	Best Continuous	Best Discrete	Simulation Input
1	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
2	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
3	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
4	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
5	DD	Gamma	Geometric	Empirical
6	DD	Gamma	Geometric	Empirical

(NE = Next-Event and DD = Daily Demand)

Figure 5.1 shows the empirical requisition inter-arrival distribution for group three (Replenishment/Low). Table 5.4 gives the results of the goodness-of-fit test of a Gamma distribution to this empirical data set for the first and last five empirical observations. The hypothesized distribution is Gamma with shape parameter equal to 0.4851 and scale parameter equal to 67.0007. In this case, the lack of fit starts after the first observation and by the fifth observed value the cumulative probability of the empirical data is 0.4017 while the cumulative probability of the hypothesized Gamma distribution is only 0.3116. A value

of 1.0 for the hypothesized cumulative distribution at each of the last five observed values implies an extremely low probability (less than 0.00000005) of generating these values. Therefore, fit in the upper tail is also inadequate.

Table 5.5 gives the results of a goodness-of-fit test for a Geometric distribution to the same empirical data set. The Geometric distribution parameter is 0.0305. In this case, the hypothesized distribution fits poorly in both the lower and upper tails of the empirical distribution.

Table 5.4

Gamma Distribution Goodness-of-fit Test Results

Cell Range	Counts Obs	Counts Exp	Empir PDF	Hypoth PDF	Empir CDF	Hypoth CDF
0-1	4198	4201	0.14541	0.14551	0.14541	0.14551
1-2	3053	1651	0.10575	0.05718	0.25115	0.20269
2-3	1806	1238	0.06255	0.04288	0.31371	0.24556
3-4	1398	1023	0.04842	0.03543	0.36213	0.28100
4-5	1141	885	0.03952	0.03064	0.40165	0.31164
1812-1815	1	0	0.00003	0.00000	0.99986	1.00000
1815-1861	1	0	0.00003	0.00000	0.99990	1.00000
1861-1867	1	0	0.00003	0.00000	0.99993	1.00000
1867-1872	1	0	0.00003	0.00000	0.99997	1.00000
1872-1878	1	0	0.00003	0.00000	1.00000	1.00000

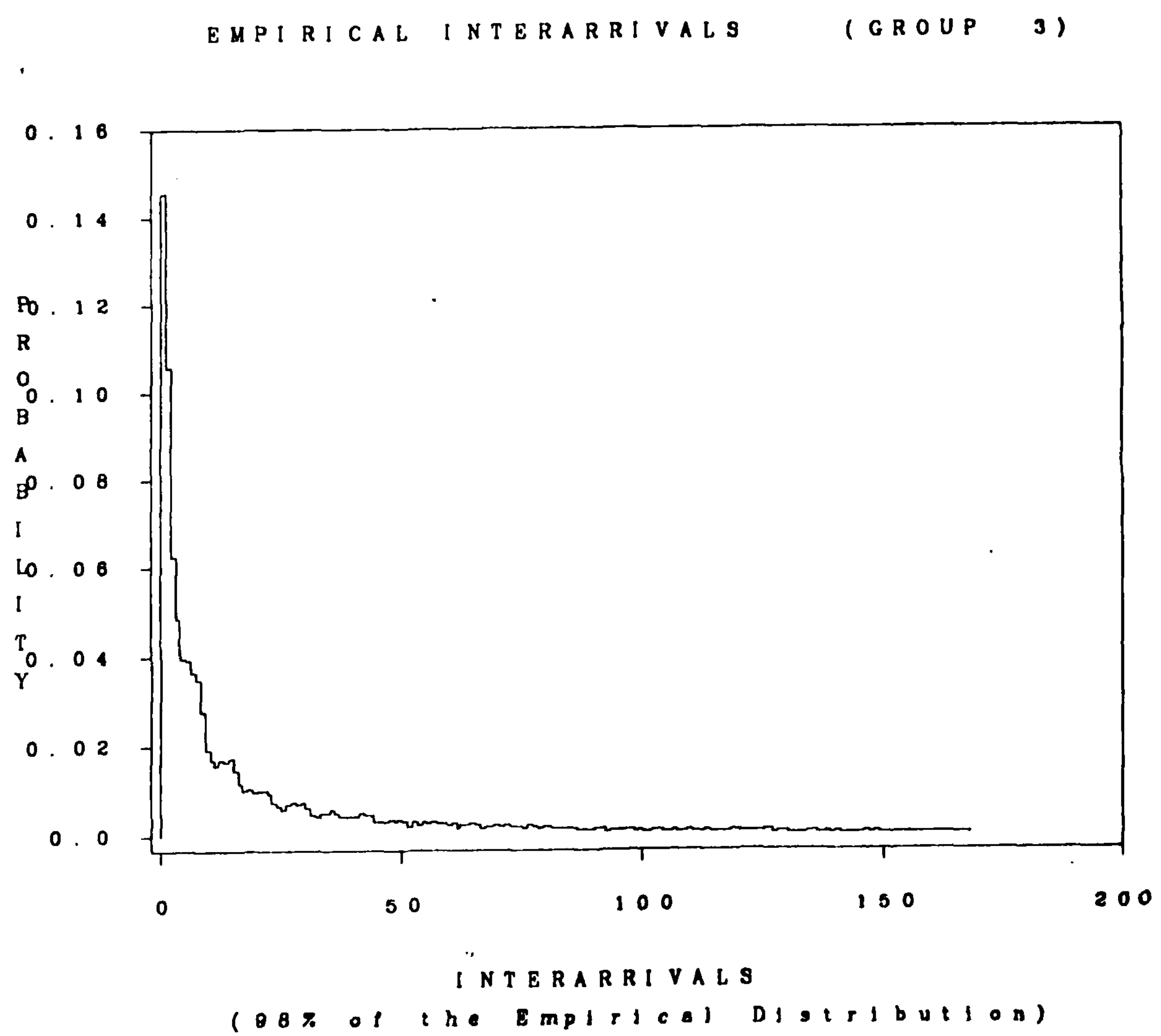
EMPIRICAL INTERARRIVALS (GROUP 3)
PROBABILITY
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
50
100
150
200
INTERARRIVALS
(98% of the Empirical Distribution)

Figure 5.1

Table 5.5

Geometric Distribution Goodness-of-fit Test Results

Class	Class Value	Observed Frequency	Expected Frequency	Test Value
1	0	4198	880.44	12500.76
2	1	3053	853.59	5667.10
3	2	1806	827.56	1156.82
4	3	1398	802.32	442.25
5	4	1141	777.86	169.53
249	261	1	0.84	0.03
250	263	1	0.52	0.45
251	267	2	0.95	1.17
252	270	1	0.64	0.21
253	1877	361	6.54	19217.57

Results for the other groups are similar. In all cases, the hypothesized Geometric distributions showed poor fit to both the lower and upper tails. The hypothesized continous distributions showed poor fit in either the lower tail, the upper tail, or in both tails.

A final observation concerning the empirical requisition size and daily demand distributions is that all groups exhibit a lack of randomness. The high empirical probabilities associated with requisition size observations of 5, 10, 20, 50, and 100 in Figure 5.2 illustrate this tendency. One possible explanation for these irregular distributions is that some requisitioners maintain their own inventories and only order from DESC at replenishment points. These replenishment points and the associated requisition sizes may be obtained through methods such as past experience and rules of thumb which cause the lumpy empirical distributions. Using any theoretical distribution

to model these empirical distributions would smooth out the lumps and result in a loss of information. Therefore, all distributions exhibiting this tendency are simulated using the actual empirical distribution. Whether or not a similar but smooth theoretical distribution would give the same results when used as a simulation input is not addressed.

Simulation. The results of the first replication of the simulation model are given in Table 5.6. The values in the table represent totals for all sample items. Simulated demand frequency and quantity are very close to the actual data after the first full year of the simulation (82-4). However, simulated demand value is almost twelve times actual demand value. The high demand value causes many items to migrate into the *Replenishment/High 2 category*. Migration into this category causes more items to be modeled using a high frequency distribution and thus, demand frequency and demand quantity increase as the simulation progresses. The extent of this migration is summarized in Table 5.7.

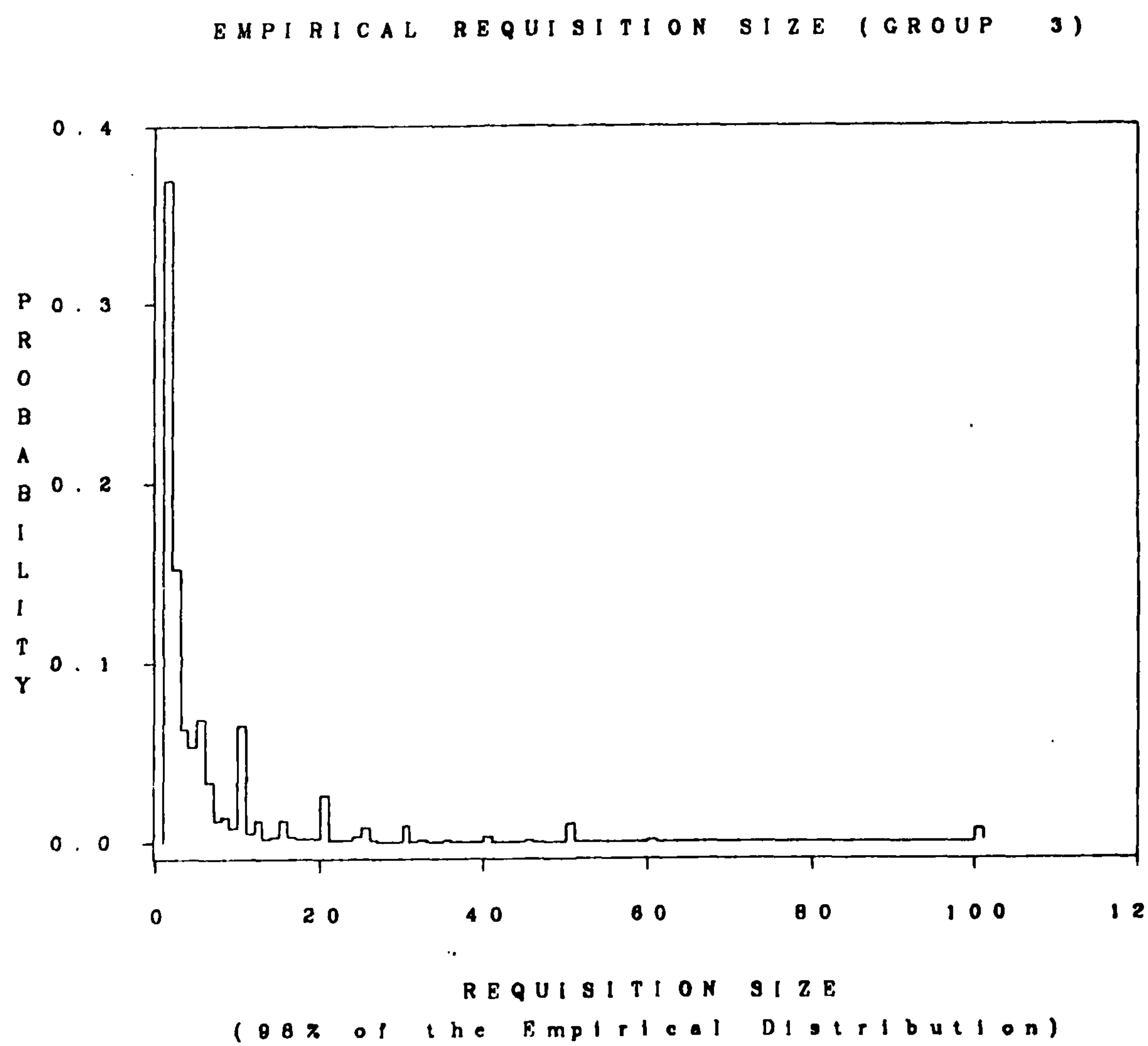
EMPIRICAL REQUISITION SIZE (GROUP 3)
PROBABILITY
0.4
0.3
0.2
0.1
0.0
0
20
40
60
80
100
12
REQUISITION SIZE
(98% of the Empirical Distribution)

Figure 5.2

Table 5.6

Simulation Results for the First Item Grouping

Quarter	Source	Demand Frequency	Demand Quantity	Demand Value
82-4	Sim	454518	7457776	1557753600
	Actual	408579	7386043	131325184
83-1	Sim	472328	7746912	1651707136
	Actual	411037	7498862	130727912
83-2	Sim	534877	8624575	1769921536
	Actual	423346	7862524	133766768
83-3	Sim	602784	9418965	1896805632
	Actual	439846	8416990	129577456
83-4	Sim	700433	10688897	2054332928
	Actual	436258	8306247	140335616
84-1	Sim	779236	11804962	2101534080
	Actual	435078	8145458	139879936
84-2	Sim	839002	12622382	2207087616
	Actual	423475	7906464	136569936
84-3	Sim	899657	13511014	2239214848
	Actual	416299	7722209	120866480
84-4	Sim	950906	14252873	2283324672
	Actual	405843	7895786	132382080
85-1	Sim	986400	14714555	2721367296
	Actual	397707	8437434	135663744
85-2	Sim	1018230	15153443	2744625664
	Actual	386241	8550595	143823520

Table 5.7

Demand Category Item Counts

Quarter	Non-Stock	NSO	Replenishment Categories R/L	R/M	R/H1	R/H2
82-4	4571	27006	3231	2859	902	2340
83-1	4497	26922	3274	2766	779	2671
83-2	4436	26891	3196	2672	693	3021
83-3	4377	26779	3175	2580	654	3344
83-4	4319	28729	1895	1880	512	3574
84-1	4243	28687	1852	1820	523	3784
84-2	4166	28625	1817	1800	514	3987
84-3	4099	28558	1791	1767	531	4163
84-4	4047	28498	1741	1768	521	4334
85-1	4002	28390	1728	1773	501	4515
85-2	3951	28279	1715	1753	533	4678

The reason for the unrealistic simulated demand value is diverse items within the same group. For instance, the requirements for Replenishment/High 2 items are: annual demand frequency of at least three requisitions, annual demand quantity of at least twenty units, and annual demand value of at least $15,000. Some of the items meeting these requirements have low price and high frequency, while others have high price and lower frequency. When the items are grouped together, the high priced items receive higher demand frequency than they should. Grouping items with diverse prices together causes the unrealistic simulated demand value. The high demand value causes item migration, which in turn causes the increasing frequency and quantity patterns revealed in Table 5.6.

More detailed simulation results are contained in Appendix D. These results include: demand frequency,

quantity, and value by management categories (D.3-D.8); frequency category item counts (D.9); item counts for each of the six demand categories in each quarter of the simulation (D.10); quarterly item migration tables (D.11-D.21); a plot of simulated versus actual migration volatility (D.22); and a plot of simulated versus actual item stability (D.23). These outputs are described in the introduction to Appendix D.

The high simulated demand value for the first item grouping does not correspond to actual DESC data. However, the migration tables in Appendix D show that items are migrating as would be expected if demand value were actually at simulation levels. This result shows that migration is being simulated within the model using item groupings based on management categories. However, evaluation of how well simulated migration compares to actual migration is difficult given the high demand value generated using this grouping.

<u>Second Item Grouping</u>

The diverse characteristics of items within the same group in the first item grouping resulted in high demand value. One problem is that items with substantially different prices are being modeled using the same distribution.

A problem occurs because item price is related to both requisition size and requisition frequency. For the most

part, items with high prices receive less frequent requisitions in smaller quantities than do items in the lower price ranges. However, when all items in the same demand category are grouped together, this distinction is lost and demand value generated as a result of this information loss is unrealistically high.

In an attempt to bring simulated demand value into line with observed demand value the second item grouping adds four price levels to the six demand categories of grouping one. The resulting 24 item groups are shown in Table 5.8.

Table 5.8

Second Item Grouping Definition

Group #	Demand Category	Item Price From	Item Price To
1	Non-stocked	0.0	2.0
2	Non-stocked	2.0	20.0
3	Non-stocked	20.0	200.0
4	Non-stocked	200.0	MAX
5	NSO	0.0	2.0
6	NSO	2.0	20.0
7	NSO	20.0	200.0
8	NSO	200.0	MAX
9	R/Low	0.0	2.0
10	R/Low	2.0	20.0
11	R/Low	20.0	200.0
12	R/Low	200.0	MAX
13	R/Medium	0.0	2.0
14	R/Medium	2.0	20.0
15	R/Medium	20.0	200.0
16	R/Medium	200.0	MAX
17	R/High 1	0.0	2.0
18	R/High 1	2.0	20.0
19	R/High 1	20.0	200.0
20	R/High 1	200.0	MAX
21	R/High 2	0.0	2.0
22	R/High 2	2.0	20.0
23	R/High 2	20.0	200.0
24	R/High 2	200.0	MAX

Data Collection. Table 5.9 gives the results of the data collection effort. Group 12 (Replenishment/Low items with prices above $200.00) has very few observations. This is expected since these are items transitioning to higher demand value categories probably due to price fluctuations.

Table 5.9

Data Collection Results for the Second Item Grouping

Group #	Daily Demand	Requisition Size	Requisition Inter-arrivals	Item Counts
1	728	871	702	1488
2	1482	1702	1275	2509
3	1025	1162	847	1557
4	356	396	294	274
5	8552	8875	4986	6493
6	18139	18913	10702	11802
7	15235	16066	9307	8470
8	3490	3707	2271	1766
9	17899	21063	18169	1163
10	11919	12787	9377	1551
11	1931	2096	1318	395
12	11	12	7	5
13	13924	21281	20890	116
14	17971	20798	19174	516
15	13473	15109	12773	875
16	1091	1182	863	147
17	21438	61094	60858	61
18	20136	29494	29003	130
19	20558	24793	23592	309
20	4278	4781	4178	214
21	9454	35784	35707	19
22	52326	116640	116022	170
23	82444	140734	138989	507
24	22975	31230	30143	372

Distribution Fitting. The theoretical distribution fitting results for group daily demand and requisition size empirical distributions were much the same as those for the

first item grouping. The non-random tendency was prevalent in all groups with requisition size observations of 5, 10, 20, 50, etc. again having very high probability relative to surrounding values. As a result, all daily demand and requisition size inputs to the simulation model for item grouping two are in the form of empirical distributions.

In contrast, several of the inter-arrival distributions for groups with low demand frequency were fit well by continuous distributions. Inter-arrivals for groups two, four, eight, and eleven are modeled using Weibull distributions. Inter-arrivals for groups three, six, and seven are modeled using Gamma distributions. As an example, the summary table for the Weibull distribution fit to group eleven's empirical inter-arrival distribution is given in Table 5.10.

Table 5.10

Weibull Distribution Goodness-of-fit Test Results

Cell Range	Counts Obs	Counts Exp	Empir PDF	Hypoth PDF	Empir CDF	Hypoth CDF
0-1	165	126	0.12519	0.09526	0.12519	0.09526
1-2	50	62	0.03793	0.04692	0.16313	0.14218
2-3	43	48	0.03263	0.03649	0.19575	0.17867
3-4	34	40	0.02580	0.03072	0.22155	0.20940
4-5	27	35	0.02049	0.02688	0.24203	0.23628
1513-1607	1	0	0.00076	0.00003	0.99986	0.99992
1607-1611	1	0	0.00076	0.00000	0.99990	0.99992
1611-1667	1	0	0.00076	0.00001	0.99993	0.99993
1667-1803	1	0	0.00076	0.00003	0.99997	0.99996
1803-1861	1	0	0.00076	0.00001	1.00000	0.99997

Table 5.11 compares the minimum, maximum, and average of the empirical data to the Weibull variates generated to represent inter-arrivals for group eleven in the simulation model. Similar comparisons are used to verify all simulation input distributions.

Table 5.11

Actual Versus Simulated Inter-arrivals for Group Eleven

Source	Observations	Minimum	Maximum	Average
Empirical	1318	0	1860	67.78
Simulated	3936	0	1802	62.30

Simulation Results. As expected, the price breakdown did result in more realistic simulated demand value. However, the items still show a tendency to migrate into the high frequency and demand value groups. This tendency results in increasingly high frequency, quantity and value over the fourteen quarters of simulated demand. The simulated demand results are summarized in Table 5.12.

After one full year of simulated demand, the simulated demand frequency and demand quantity are close to actual frequency and quantity. Simulated demand value is still high (about 40% over actual demand value) but much closer than in the first item grouping. Appendix D contains a full set of simulation results for this item grouping.

Table 5.12

Simulated Demand Results for Grouping Two

Quarter	Source	Demand Frequency	Demand Quantity	Demand Value
82-4	Sim	404976	6484416	181200720
	Actual	408579	7386043	131325184
83-1	Sim	399605	6460721	185327328
	Actual	411037	7498862	130727912
83-2	Sim	412216	6864375	195481040
	Actual	423346	7862524	133766768
83-3	Sim	446596	7629403	217223328
	Actual	439846	8416990	129577456
83-4	Sim	505564	8862398	247540080
	Actual	436258	8306247	140335616
84-1	Sim	568448	10364392	279235648
	Actual	435078	8145458	139879936
84-2	Sim	615696	11655631	294973120
	Actual	423475	7906464	136569936
84-3	Sim	678460	13338555	328110720
	Actual	416299	7722209	120866480
84-4	Sim	714214	14546019	334812608
	Actual	405843	7895786	132382080
85-1	Sim	749143	15651777	342723648
	Actual	397707	8437434	135663744
85-2	Sim	814362	17182984	366566688
	Actual	386241	8550595	143823520

The tendency for items to migrate into the Replenishment/High 2 demand category in the first item grouping is also evident in this grouping. The migration tables in Appendix D show that migration is being simulated. Simulated migration for most quarters is close to actual migration with the exception of a higher percentage of items remaining in their current categories.

Third Item Grouping

The improvement in simulated demand value gained by including the four price levels in grouping two led to adding more price levels in grouping three to determine if

further improvement in simulated demand value could be obtained. Instead of the four price levels of grouping two, the third item grouping uses six price levels in addition to the six management categories. The six price levels are 2, 20, 100, 500, 5000, and above. The resulting total number of groups is 36.

The addition of two more price levels did not result in improvement to the simulated demand for the third grouping. Simulation results for grouping three correspond closely with those of the second item grouping. These results are given in Appendix D. Data collection and distribution fitting results are given in Appendix E.

The additional price breakdowns for higher priced items was an attempt to control the increase to simulated demand value. The results do not necessarily show that further price breakdowns would not lead to more realistic simulated demand value. Altering the levels in the lower price ranges may improve results. However, no further attempts are made to investigate other item price groupings. Rather, the next item characteristic investigated is annual demand frequency.

Fourth Item Grouping

The fourth grouping uses three item characteristics: demand category, price, and annual demand frequency. The four demand category code levels used are two, three, four, and six. The difference between this grouping and the first three with respect to demand categories is that Non-stocked

and NSO items are grouped together and Replenishment/High 1 and Replenishment/High 2 items are grouped together. The reason for decreasing the number of demand categories is to hold down the total number of groups. Justification for grouping Non-stocked and NSO items together is that previous groupings show that distributions for the items in these two categories are similar. Justification for grouping the two high value Replenishment categories together is also similar distributions. In this case, the main difference is demand frequency, which is taken into account by also grouping on demand frequency levels.

The price levels for this grouping are identical to the price levels used in grouping two: 2, 20, 200, and above. The annual demand frequency levels used are 1, 20, 199, and above. The reason for including demand frequency breakdowns is the problem of high demand value in the simulation results for the first three item groupings. Item counts in the five frequency categories for the previous three groupings (see pages D.9, D.30, and D.51) show a higher number of items in the ten to nineteen frequency category than actual data and a lower number in the one to nine frequency category. This is one cause of the high simulated demand value in previous groupings and should improve when item groupings include demand frequency levels.

Data Collection. The results of the empirical data collection effort for the 64 groups are given in Appendix

E. Several groups contain either zero or very few observations. These groups represent item characteristic combinations which are either non-existent or very improbable in the DESC item population.

<u>Distribution Fitting</u>. The distributions used in simulating demand for grouping four are summarized in Appendix E. All groups with empirical requisition size observation counts of 20 or less are modeled using the empirical distributions. The affect of these item groups on simulation results is negligible.

Several inter-arrival distributions are simulated using theoretical distributions. Inter-arrivals for groups 2, 23, 26, 34, and 37 are simulated using Weibull distributions. Inter-arrivals for groups 6, 10, 41, and 45 are simulated using Gamma distributions. Inter-arrivals for group 40 are simulated using a Geometric distribution.

Two of the requisition size distributions are also modeled using theoretical distributions. Requisition sizes for group 8 are modeled using a Geometric distribution and requisition sizes for group 34 are modeled using a Weibull distribution.

Most requisition size distributions and all daily demand distributions exhibit the non-random tendencies discussed in the analysis of previous groupings. The empirical probabilities associated with values of 5, 10, 20, 50, etc. are high in relation to surrounding values.

Simulation Results. Simulated demand results are summarized in Table 5.13. Demand frequency is low after the first full year of the simulation and increases as the simulation progresses. The final demand frequency comparison shows simulation results to be about 14% higher than actual data. Demand quantity is also low after the first full year and increases over the course of the simulation run. However, simulated demand quantity is still below actual demand quantity by approximately 10% in the last comparison. Annual demand value at the end of the first full year of the simulation is close to actual demand value. However, over the eleven quarters of the simulation run, simulated demand value also increases with the final value being about 43% above actual demand value.

Demand frequency category item counts still show more items in the ten to nineteen category in the simulation than in the actual data (see page D.72). However, simulated versus actual demand frequency category item counts are closer than in previous groupings (see pages D.9, D.30, and D.51).

Table 5.13

Simulated Demand Results for Grouping Four

Quarter	Source	Demand Frequency	Demand Quantity	Demand Value
82-4	Sim	360267	5851541	145598560
	Actual	408579	7386043	131325184
83-1	Sim	356049	6007294	146019472
	Actual	411037	7498862	130727912
83-2	Sim	348532	6021115	143703584
	Actual	423346	7862524	133766768
83-3	Sim	361598	6422263	150105008
	Actual	439846	8416990	129577456
83-4	Sim	374649	6717937	159651920
	Actual	436258	8306247	140335616
84-1	Sim	385140	7086417	170557840
	Actual	435078	8145458	139879936
84-2	Sim	396014	7241728	179085472
	Actual	423475	7906464	136569936
84-3	Sim	399432	7194895	184131872
	Actual	416299	7722209	120866480
84-4	Sim	421279	7642809	196019680
	Actual	405843	7895786	132382080
85-1	Sim	427948	7501369	200505584
	Actual	397707	8437434	135663744
85-2	Sim	439533	7747115	205830896
	Actual	386241	8550595	143823520

Simulated migration results in a high number of items in the Replenishment/High 2 category and a low number of items in the Replenishment/Low category. This migration causes the high demand value reported in Table 5.13. Item counts in the other two Replenishment categories at the end of the simulation run correspond well with actual item counts. The NSO item count is high and the Non-stocked item count is low. However, since migration to the Non-stocked category is not modeled, a better comparison is the total item count in both of these categories. The combined item count for these two categories is 33,865 at the end of the

simulation. This corresponds well to the actual item count of 32,609 for these two categories.

Fifth Item Grouping

The fifth and final item grouping investigates two demand based item characteristics: annual demand frequency and average requisition size. This grouping provides a contrast to previous groupings and also gives results for one item characteristic (average requisition size) which is not used in the first four groupings.

The frequency levels used are: 2, 10, 20, 200, and above. The average requisition size levels for this grouping are: 2, 10, 25, 100, and above. This combination of frequency and average requisition size breakdowns results in 25 total groups.

Data Collection. The results of the empirical data collection effort for the 25 groups are given in Appendix E. An important observation resulting from this item grouping is that inconsistencies exist between the Requisition History data and the Fractionation data. For instance, calculating annual requisition frequency based on Requisition History data will not always results in the same number as the annual requisition frequency recorded on the Fractionation data file. These files are sometimes closed out on different days because of computer scheduling constraints. In addition, as mentioned earlier, Fractionation files for two of every four quarters do not

contain entries for Non-stocked items.

The inconsistencies become apparent when grouping items using characteristics from the two separate sources of information. As an example, given a grouping defined as items with annual demand frequency equal to one and average requisition size greater than twenty, requisition size observations less than twenty should not appear in the empirical distribution. However, because the Requisition History data for an item in this group could contain more than one requisition (or annual requisition frequency greater than one), requisition size observations less than twenty are possible.

Distribution Fitting. The simulation input distributions resulting from the goodness-of-fit analysis are given in Appendix E. Two discrete theoretical distributions provide a good fit to empirical requisition size data sets: the Poisson for group six and the Geometric for group eleven.

Appendix F contains empirical distribution plots for this item grouping. These plots show the non-random tendencies in the requisition size and daily demand distributions. For example, in the requisition size plot for group 13, values of 10, 20, 30, 40, and 50 are easily distinguishable and have much higher probability than the surrounding values. This grouping contains items with annual demand frequencies of greater than 10 and less than

or equal to 20 and average requisition sizes greater than 10 and less than or equal to 25. The plot represents the probability associated with a total of 2,064 observations.

Simulation Results. Table 5.14 summarizes the simulated demand results for the fifth item grouping. Simulated annual demand frequency remains relatively constant over the first three quarters and then begins a steady increase. The last value is approximately 13% above actual annual demand frequency. Simulated annual demand quantity is stable and remains lower than actual annual demand quantity throughout the simulation. Simulated annual demand value is above actual annual demand value for the entire simulation. However, unlike the results of previous groupings, simulated annual demand value actually decreases in the middle portion of the simulation run and ends up only 9% above actual annual demand value.

Table 5.14

Simulated Demand Results for the Fifth Item Grouping

Quarter	Source	Demand Frequency	Demand Quantity	Demand Value
82-4	Sim	361746	6035236	141024816
	Actual	408579	7386043	131325184
83-1	Sim	353177	5973149	146817072
	Actual	411037	7498862	130727912
83-2	Sim	356783	6240938	170411280
	Actual	423346	7862524	133766768
83-3	Sim	364440	6253372	173436592
	Actual	439846	8416990	129577456
83-4	Sim	374656	6015161	162090352
	Actual	436258	8306247	140335616
84-1	Sim	386536	6131238	163724976
	Actual	435078	8145458	139879936
84-2	Sim	396825	5930088	144928032
	Actual	423475	7906464	136569936
84-3	Sim	407990	5929818	147392016
	Actual	416299	7722209	120866480
84-4	Sim	418597	5950766	150034368
	Actual	405843	7895786	132382080
85-1	Sim	428942	5865455	155786000
	Actual	397707	8437434	135663744
85-2	Sim	437536	5790638	158187504
	Actual	386241	8550595	143823520

Demand frequency category item counts at the end of the simulation (see page D.93) show a higher number of simulated items in the 20 - 199 category and a lower number in the 1 - 9 category than the actual item counts in these two frequency categories. The high number of items in the 20 - 199 category is one reason for the high simulated annual demand frequency reported in Table 5.14.

Demand category item counts (see page D.94) at the end of the simulation period show a higher number of Non-stocked and NSO items than the actual number of items in these two management categories and a substantially smaller number of

Replenishment/Low items than the actual Replenishment/Low item count.

As in previous groupings, the simulation initial conditions result in a large degree of migration after the first full year of demand has been generated. After the high initial migration, items tend to be more stable in the simulation than in actual data. Simulated category stability percentages (along the diagonal in pages D.96 - D.105) are higher than actual category stability percentages in almost every case.

These results emphasize how different item groupings can result in entirely different simulation results. In contrast to the first four item groupings, the final grouping resulted in relatively stable demand measures. However, simulated migration is, for the most part, significantly lower than actual migration.

<u>Migration Comparison Across Groupings</u>

A comparison of how well migration is modeled using the five groupings is difficult because of the dependency of migration results on the simulated demand value. Simulated demand value is high for all five groupings. In the first four groupings, high demand value results in migration towards the higher demand value categories. However, a relative comparison of the five groupings can be made by using the "squared difference" calculation included with the simulated migration results for each quarter. Table 5.15

contains this comparison of the five item groupings.

Table 5.15

Comparison of Simulated Item Migration Across Groupings

	Grouping Number				
Quarter	1	2	3	4	5
82-4	1.5754	0.3653	0.3253	0.5962	0.8625
83-1	0.2743	0.2239	0.2327	0.2262	0.2339
83-2	0.1150	0.0372	0.0386	0.0410	0.0289
83-3	0.0983	0.0766	0.0939	0.0614	0.0601
83-4	0.5237	0.1303	0.2060	0.1004	0.0819
84-1	0.2057	0.0647	0.0701	0.0749	0.0502
84-2	0.2002	0.0849	0.0900	0.0926	0.0648
84-3	0.1324	0.0970	0.0936	0.0943	0.0559
84-4	0.0648	0.0518	0.0419	0.0396	0.0410
85-1	0.0878	0.0836	0.0732	0.0534	0.0497
85-2	0.1302	0.0758	0.0803	0.0839	0.0588

Simulated migration in the first quarter (82-4) does not correspond to actual migration. A large number of items migrate from NSO to Replenishment categories and from Replenishment categories to NSO. Two possible reasons for this large simulated migration are missing inter-arrival observations and simulation start-up conditions. Missing inter-arrival observations are due to missing quarters of data. Of the thirteen quarters in the data analysis period, only nine contain complete data. Quarters with incomplete data are not used. The four quarters with missing data are interspersed among the good quarters causing many inter-arrival observations to be lost. The loss is more significant for low frequency items, many of which are categorized as NSO items. Simulation initial conditions also affect migration in the first quarter. Initial

smoothing values, smoothing factors, and initial inter-arrival generation all affect simulated item migration after the first full year of demand has been generated. Decreasing values for each of the four item groupings in the first three quarters of the simulation point to initial conditions as the major cause of high simulated migration in these quarters.

High values for each grouping in quarter 83-4 are the result of the high initial migration from NSO to the Replenishment categories. Once an item migrates up to Replenishment status it cannot migrate back down for one full year. Many of the items which migrated up initially do not maintain the necessary levels of demand frequency, quantity, and value to remain as Replenishment items. However, these items are not allowed to migrate back down until one full year has passed. The build-up of items waiting to migrate back down results in the high percentages reported for quarter 83-4 in each item grouping.

The item stability plots for the five item groupings (see pages D.22, D.43, D.64, D.85, and D.106) show reasonably close correspondence between actual and simulated item stability. In all five groupings, simulated stability in the same category for the entire simulation period is higher than actual item stability. Migration volatility plots for the five item groupings (see pages D.23, D.44, D.65, D.86, and D.107) show the number of simulated

migrations of one category is smaller than the actual number of migrations of one category. The number of simulated migrations of two and three categories are larger than the actual number of migrations of two and three categories.. However, for groupings four and five, the differences between the number of simulated migrations of two or more categories and the number of actual migrations of two or more categories are small. The differences in the number of stable items and in the number of migrations of one category are partially due to the lack of simulated migrations from NSO to Non-stocked and vice versa.

<u>Summary</u>

This chapter gave data collection, distribution fitting, and simulation results for the five item groupings which were investigated. Most of the empirical distributions were not modeled using theoretical distributions due to the non-random tendencies seen in the empirical distribution plots. Simulation results were very dependent on the item characteristics used to define the groupings. Results for the final grouping did show a reasonable correspondence to actual demand data. However, simulated migrations after the first full year of the simulation were high compared to actual migrations and simulated migrations in later quarters of the simulation run were lower than actual migrations.

The next chapter summarizes the research, provides

conclusions based on the analysis of a limited number of item groupings and gives recommendations for future efforts.

AD-A167 126 ESTIMATION OF INVENTORY ITEM DEMAND DISTRIBUTIONS: MODELING ITEM MIGRATIO..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH K P SMITH DEC 85 2/4

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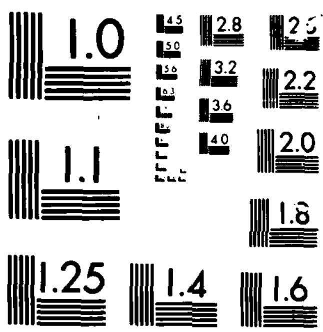

MICROCOP' CHART

VI. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The present simulation model in use at DESC does not consider item migration. The distributions used to model demand for individual items do not change over time. As a result, items remain in the same category indefinitely. In reality, DESC inventory item demand patterns change over time. The system is dynamic. However, the model used to evaluate the system assumes a static situation. As a result, conclusions drawn from analyses using the current simulation are suspect. The model needs to represent the dynamics of changing item demand patterns and item migration, especially when simulating the system over extended periods.

Summary

The purpose of this thesis was to improve the DESC inventory policy simulation model by developing a technique to model item migration, changes in item demand and management categories. The approach taken modeled demand from distributions created by grouping items rather than from individual demand distributions. Items were grouped according to characteristics such as demand frequency and price. Item demand patterns change by allowing the item's input distributions to change. This approach provides a representation of the actual reasons for item migration.

Historical data for a sample of inventory items were collected from two DESC databases. These data provided item

characteristics; empirical requisition size, daily demand, and requisition inter-arrival distributions; and actual demand and migration data for comparison to simulation results.

The historical database covered almost seven years of data for the item sample. The first thirteen quarters were used to develop item characteristics, define item groupings, and provide detailed requisition size and frequency data for the empirical distributions. The last fourteen quarters of data were used to compare against simulation results.

Goodness-of-fit tests were done on the group empirical distributions for a number of theoretical distributions. The theoretical distributions were evaluated using chi-square test statistics and on how well they represented extreme values. Distributions resulting from the goodness-of-fit testing process were used to simulate inventory item demand and migration.

Simulation results were evaluated against actual DESC demand and migration data for the item sample. Demand comparisons included requisition frequency, demand quantity, and demand value. Migration comparisons included the percent of migration from a given demand category to the other categories, item stability, and the volatility of migrations.

Conclusions

The item groupings which were evaluated were based upon

four item characteristics: demand category, item price, annual demand frequency, and average requisition size. The empirical demand distributions for these groupings showed non-random tendencies and extreme values which could not be modeled using theoretical distributions. Simulation results showed that using demand distribution based on item groups did result in simulated item migration. However, the simulated item migration did not compare well with actual migration for the item sample. Difficulties were encountered in evaluating the item groupings because of the dependencies between simulated demand and simulated migration. For instance, when the demand distributions result in high migration into certain categories, the resulting change in item demand can lead to even greater migration.

Empirical requisition size and daily demand distributions for the item groups showed non-random tendencies. These distributions had high probabilities associated with non-adjacent values such as 5, 10, 20, and 50. Modeling these empirical distributions using the common theoretical distributions would smooth out the irregularities and results in a loss of information. Whether or not this information loss would affect key simulation results is unclear and needs to be examined in future efforts.

The migration resulting from simulated demand for the

sample of items did not accurately model actual item migration. The probabilities of migration into some categories were higher than others. The number of items in each demand category by the end of the simulation was different than actual demand category item counts. For instance, for the first item grouping, simulated demand and migration resulted in over twice as many Replenishment/High 2 items at the end of the simulation period as there were in the actual data. Items had a higher probability of moving to either high or low demand categories in the simulated migration figures than in the actual sample migration. In addition, there was a higher probability of item stability in the later quarters of simulation results.

The dependency between simulated demand and simulated migration produced a dynamic modeling environment. Incorrectly specified distributions resulted in migration patterns which were not representative of actual migration. Incorrect migration patterns resulted in incorrect demand which caused further migration.

The technique employed in this thesis required an item grouping be specified. Simulation results were sensitive to the item characteristics used to define the item groups. This sensitivity coupled with the dependencies between item demand and item migration made it difficult to determine a set of item characteristics and the associated item groups which would provide a good representation of item demand and

migration.

Recommendations

This analysis has resulted in a better understanding of inventory item demand distributions and the affects of using these demand distributions to model migration. However, the technique employed in this research did not provide a mechanism to control migration. Item migration resulting from demand generated in the simulation model should be controlled at levels specified by the user. Controlling migration would eliminate the problems caused by the dependencies between simulated demand and simulated migration. Controlling migration would also allow sensitivity analyses to be performed on the affects of different levels of item migration.

One way in which migration could be controlled is by specifying constraints on the percent of items migrating from a given management category into the other categories. A transition matrix, like the one used by Kirchoff and Hobson in their research into modeling migration using a Markov chain, could be used as the migration control mechanism.

Given a migration control mechanism, other item characteristics should be evaluated to determine a set of characteristics and the associated item groups which will provide a good representation of actual demand. Demand based characteristics such as demand frequency and average

requisition size seem to be the most promising. In addition, an item stability measure based on demand characterisics such as the standard deviation of requisition size observations could provide more representative simulation results.

Work is also needed in the area of choosing the item sample. Problems associated with simulating demand and migration for a stratified item sample could be investigated further. Simulation results from a random item sample could be compared against the results from the stratified sample used in this research.

Further research into these areas will improve DESC simulation analysis. Better simulation analysis will aid policy making and improve system evaluation in a very large and complex inventory system.

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Appendix A

Data File Descriptions

This appendix contains descriptions of the original tape files transferred from DESC and the working files used in the analysis. Three files were transferred from DESC for use on the AFIT VAX 11-785/VMS computer system. These are the files resulting from the sample item data collection effort described in Chapter III. The first file contains 799,388 requisitions. Each record of this file contains data for one requisition. Record content is given in Table A.1. Tape format is 26 byte fixed length records and 26,000 byte fixed length blocks. Tape density is 1,600 bits per inch (BPI).

Table A.1

Requisition History File Description

Data Element	Starting Position	Ending Position	Length	Format
Item Stock Number (ISN)	1	13	13	
Federal Stock Class (FSC)	1	4	4	I4
Nato Designator	5	6	2	I2
National Stock Number	7	13	7	I7
Requisition Quantity	14	18	5	I5
Requisition Type	19	19	1	I1
Requisition Priority	20	21	2	I2
Date of Requisition	22	26	5	I5

The second file transferred from DESC spans two tape volumes. This file contains Fractionation data for the sample items during the data analysis period. Each record

contains quarterly data for a single item. Record content is given in Table A.2. Quarter number identifies the data period. Quarters are numbered sequentially with January through March of 1978 being number one. The maximum quarter number entry on this tape is 16 (October through December of 1981). A special entry for each item is included on this tape. These 40,909 entries identify the sample ISNs. Each entry contains zeros for each data element after the ISN. Tape format is 96 byte fixed length records and 28,800 byte fixed length blocks. Tape density is 1,600 BPI.

Table A.2

Fractionation Data File Description

Data Element	Start	End	Length	Format
Item Stock Number	1	13	13	I13
Supply Status Code (SSC)	14	14	1	A1
Very Important Program Code	15	15	1	A1
Age of Item	16	16	1	A1
Item Category Code	17	17	1	A1
Demand Value Code	18	18	1	A1
Safety Level Code	19	19	1	A1
Unit Price	20	29	10	I10
Date Management was Assumed	30	34	5	I5
Date of Last Demand	35	39	5	I5
Annual Demand Quantity	40	49	10	I10
QFD (Established Item)	50	59	10	I10
QFD (New Item)	60	69	10	I10
Annual Demand Frequency	70	79	10	I10
Future SSC	80	80	1	A1
Non-stock Code	81	81	1	A1
Weapon System Code	82	82	1	A1
Unit of Issue	83	84	2	A2
Family FSN Count	85	94	10	I10
Quarter Number	95	96	2	I2

The third file transferred from DESC also spans two tape volumes. This file contains Fractionation data for the

simulation period (from January through March of 1982 up to April through June of 1985). The record contents, tape format, and tape density are the same as for the data analysis period Fractionation file. Quarter numbers for this file range from 17 to 30.

Six working files were created from the three data sets described above. Unformatted input and output is used in the working files to save space. The first file (SAMPLE.DAT) contains the full ISN for each item in the sample. The records are accessed sequentially in ascending ISN order. The first two bytes of each record are the Item FSC (Integer * 2), the next byte is the Nato Designator (Integer * 1), and the last four bytes are the National Stock Number (Integer * 4).

The second working file (NSNALL.ID) contains file control information for reading both the Requisition History and Fractionation data working files. In addition, this file contains item characteristic data for July through September of 1981. Record content is given in Table A.3. The records in this file contain data for the ISN on the corresponding record of SAMPLE.DAT.

Table A.3

Control File Record Contents

Data Element	Start	End	Length	Type
Federal Stock Class	1	1	1	I*1
Number of Requisitions (Total)	2	3	2	I*2
Number of Fractionation Entries (Data Analysis Period File)	4	4	1	I*1
Number of Fractionation Entries (Simulation Period File)	5	5	1	I*1
Demand Category (81-3)	6	6	1	I*1
Number of Requisitions (81-3)	7	8	2	I*2
Max Requisition Quantity (81-3)	9	12	4	I*4
Avg Requisition Quantity (81-3)	13	16	4	R*4
Avg Requisition Priority (81-3)	17	20	4	R*4
Avg Requisition Type (81-3)	21	24	4	R*4
Demand Category Stability Factor	25	25	1	I*1
Item Price (81-3)	26	29	4	R*4
Annual Demand Quantity	30	33	4	I*4

The third working file (CAT81.DAT) contains demand category codes for the sample items. Again, the records of this file contain data for the ISN on the corresponding record of SAMPLE.DAT. Record contents are the 12 demand category codes for the item, one for each quarter in the data analysis period (except April through June of 1980, which is missing). Each demand category code is a 1-byte integer variable.

The fourth working file (CAT85.DAT) contains 14 demand category codes, one for each quarter in the simulation period. File format is the same as that for CAT81.DAT.

The fifth working file (RQNNUM.DAT) contains the actual requisition history data. Record content is given in Table A.4. This file resides on magnetic tape (AFIT Tape # 422) and is processed sequentially. The RQNNUM.DAT file is used

in conjunction with the NSNALL.ID file. The second data element for each item on NSNALL.ID is a count of the number of requisitions for that item. The requisitions are read from RQNNUM.DAT. If the requisition count is zero, no requisitions were collected for the item.

Table A.4

Requisition History Working File Description

Data Element	Starting Position	Ending Position	Length	Format
Requisition Quantity	1	4	4	I*4
Requisition Type	5	5	1	I*1
Requisition Priority	6	6	1	I*1
Date of Requisition	7	8	2	I*2

The final working file (NEWF81.DAT) contains Fractionation data. This file has four records for each sample item with a positive Fractionation data count (element three of the NSNALL.ID file). The first record contains three 1-byte integer variables. The value of these variables determines how the next three records will be read. A value of one means read nine 1-byte values, two means read nine 2-byte values, and three means read nine 4-byte values. This organization saves disk space by using the minimum size storage possible for the given data. The four records are shown in Table A.5. The nine values in records two, three, and four represent the corresponding item characteristic in each quarter for which both Requisition History and Fractionation data are available.

Table A.5

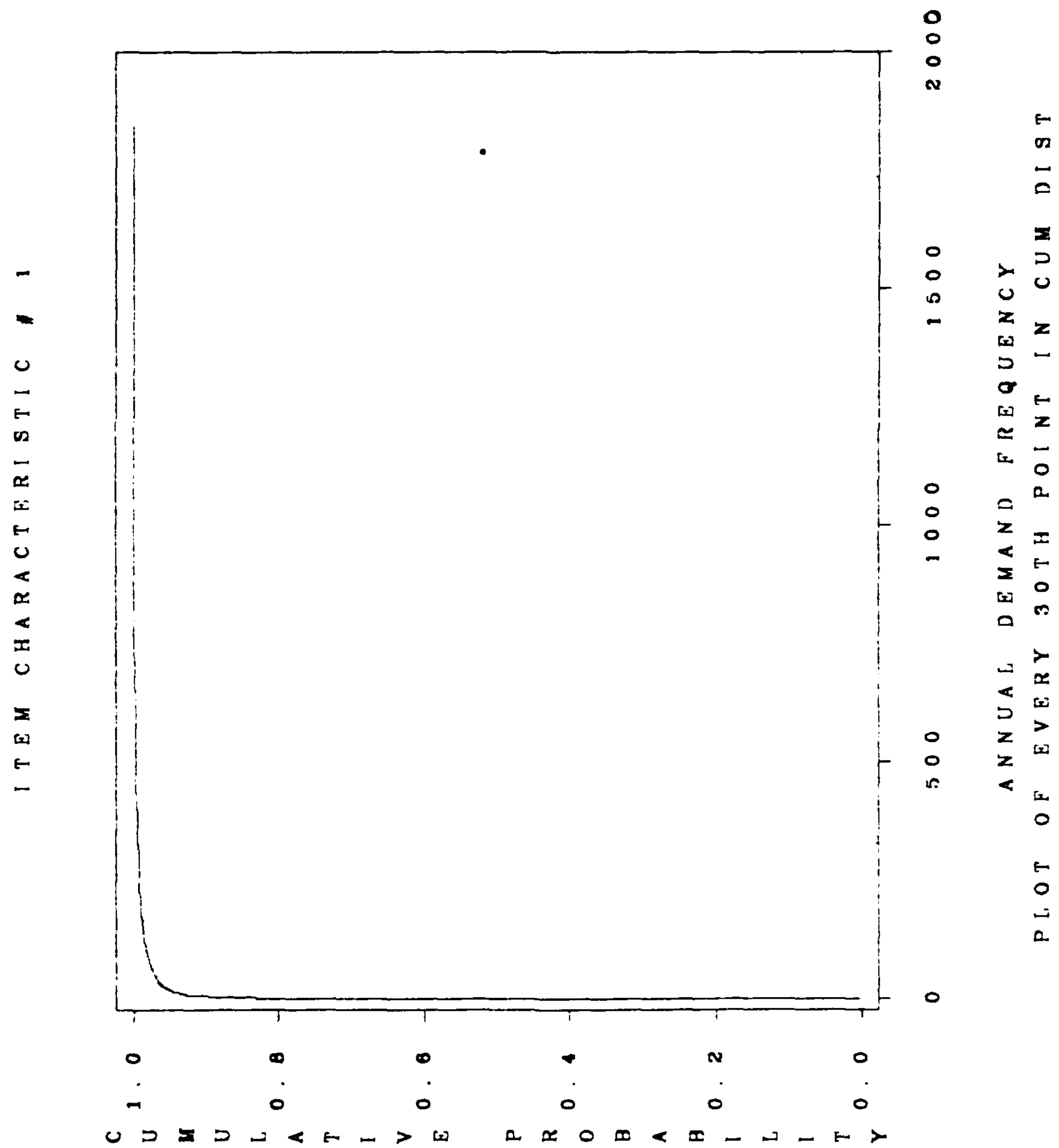
Fractionation Data Working File Description

Record #	Data Description
1	Variable Size Identifiers for Next 3 Records
2	Annual Demand Frequency Values
3	Annual Demand Quantity Values
4	Item Prices

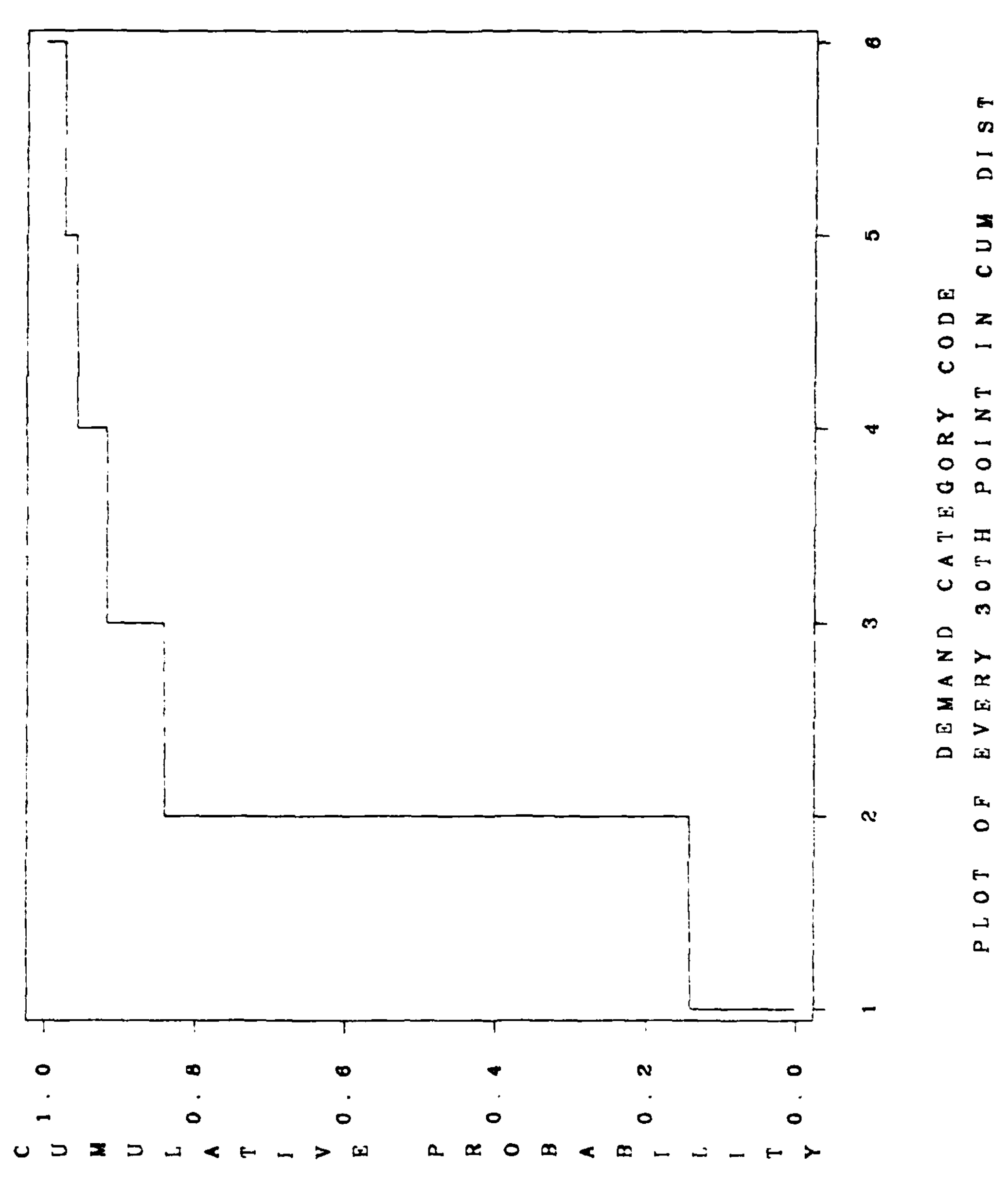
Appendix B

Item Characteristic Distributions

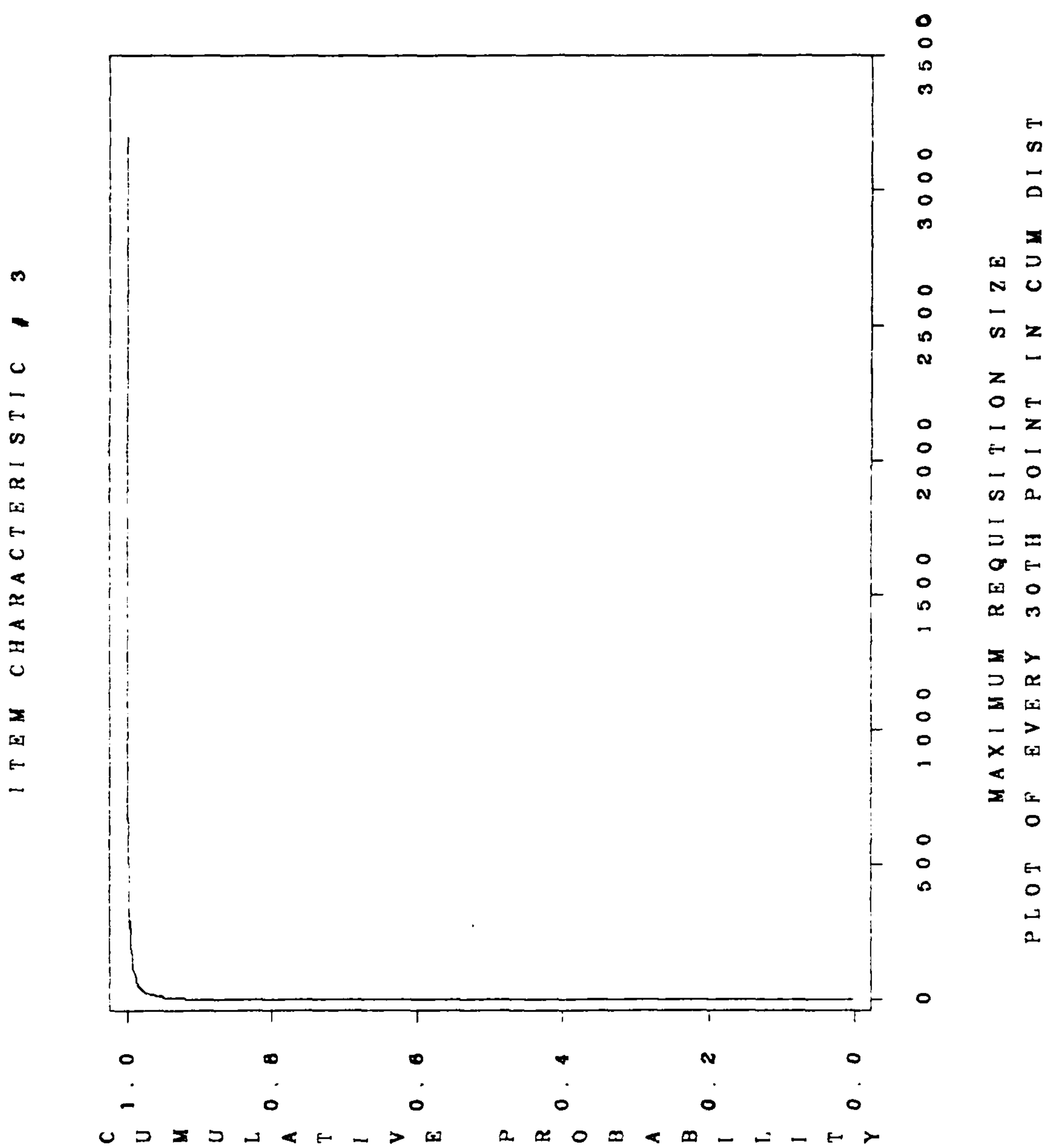
This appendix contains distribution plots for the eleven item characteristics used in grouping the DESC inventory items. The data for each plot is developed by first creating a 40,909 element array containing the item characteristic for each item. The array is sorted in ascending order and every 30th point is retrieved and used in the plot. Item characteristic levels are given on the horizontal axis and the cumulative probabilities associated with the item characterisitic levels are plotted on the vertical axis.



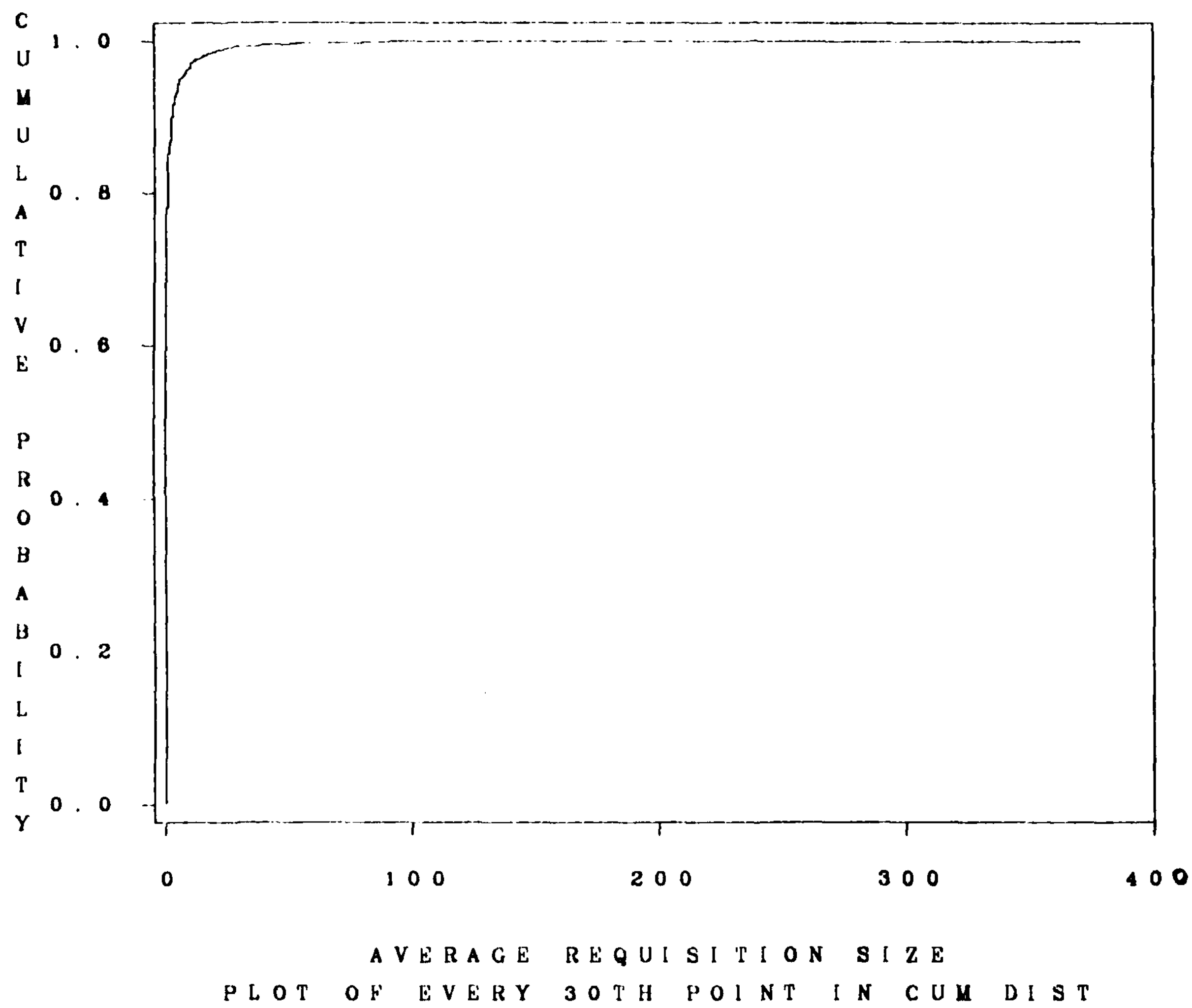
ITEM CHARACTERISTIC # 1
CUMULATIVE PROBABILITY
1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
ANNUAL DEMAND FREQUENCY
PLOT OF EVERY 30TH POINT IN CUM DIST

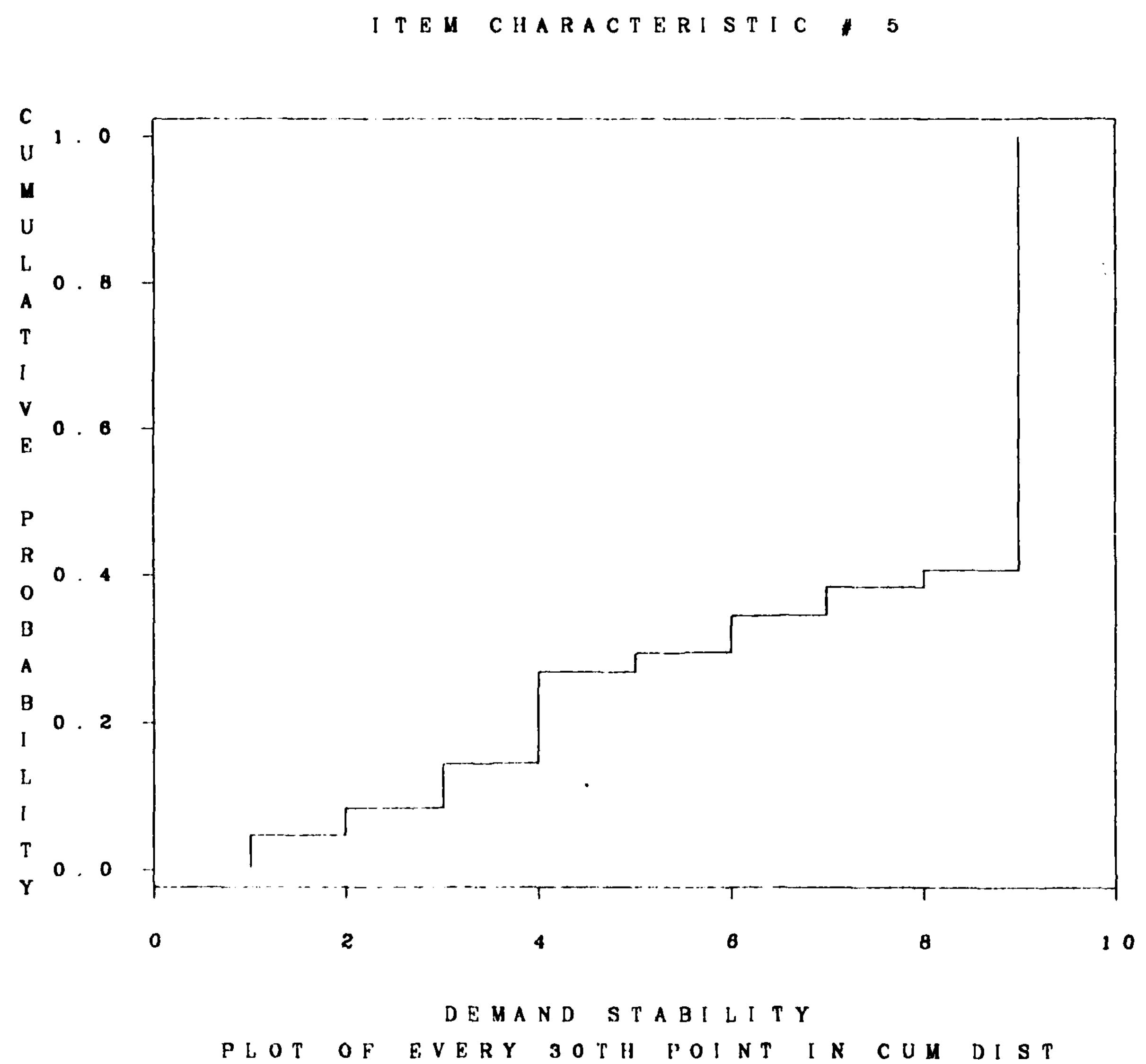

ITEM CHARACTERISTIC # 2
CUMULATIVE PROBABILITY
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
DEMAND CATEGORY CODE
PLOT OF EVERY 30TH POINT IN CUM DIST

B.3


ITEM CHARACTERISTIC # 3
CUMULATIVE PROBABILITY
1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500
3000
3500
MAXIMUM REQUISITION SIZE
PLOT OF EVERY 30TH POINT IN CUM DIST

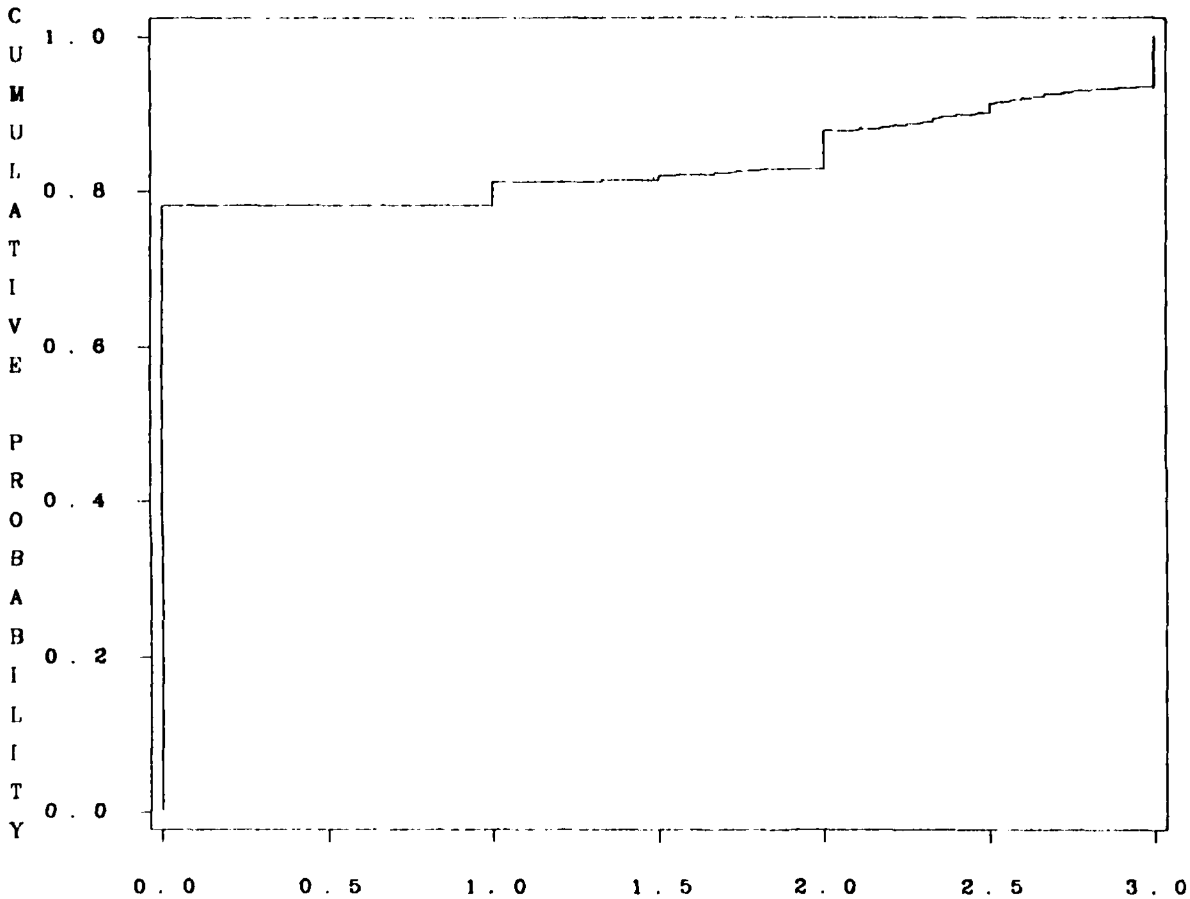
ITEM CHARACTERISTIC # 4




ITEM CHARACTERISTIC # 5
CUMULATIVE PROBABILITY
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
DEMAND STABILITY
PLOT OF EVERY 30TH POINT IN CUM DIST

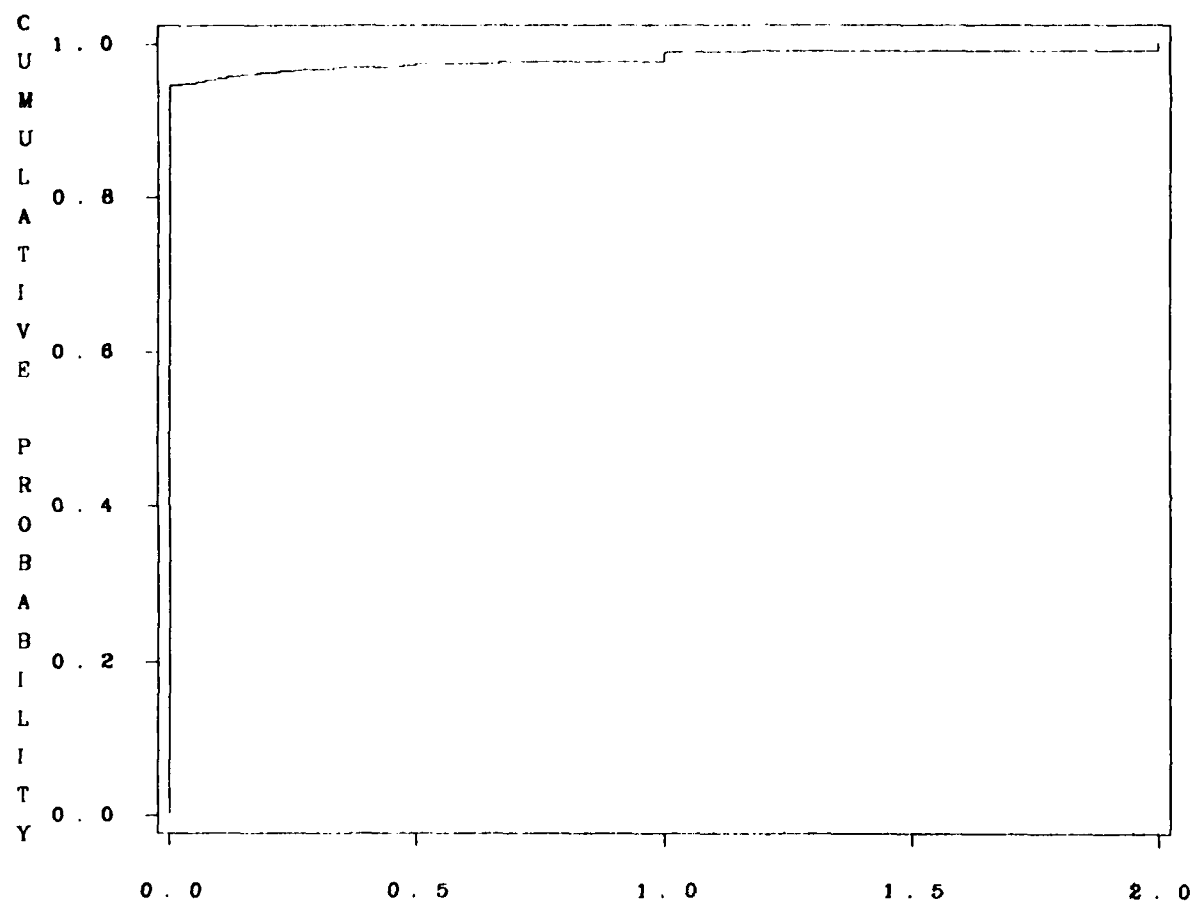
B.6

ITEM CHARACTERISTIC # 6



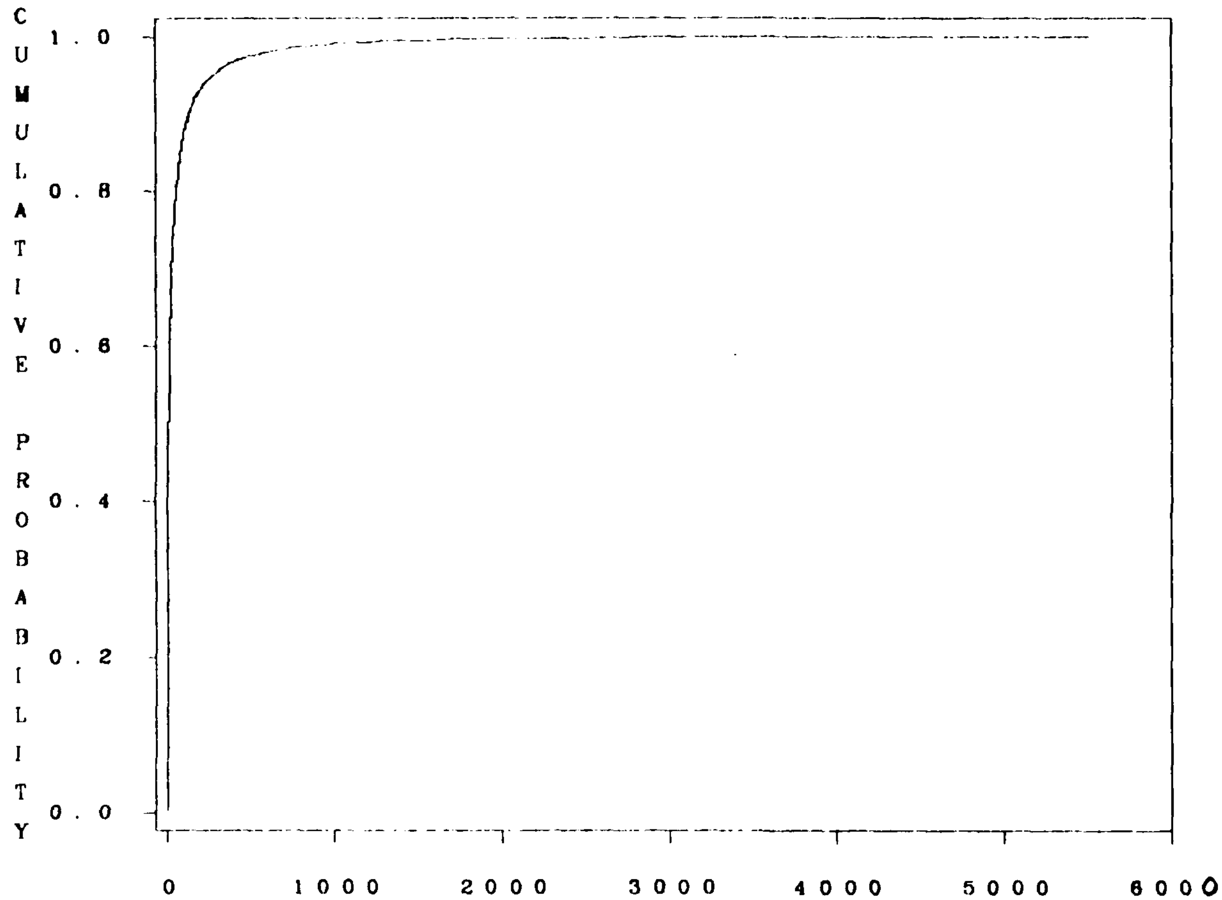
AVERAGE REQUISITION PRIORITY
PLOT OF EVERY 30TH POINT IN CUM DIST

ITEM CHARACTERISTIC # 7



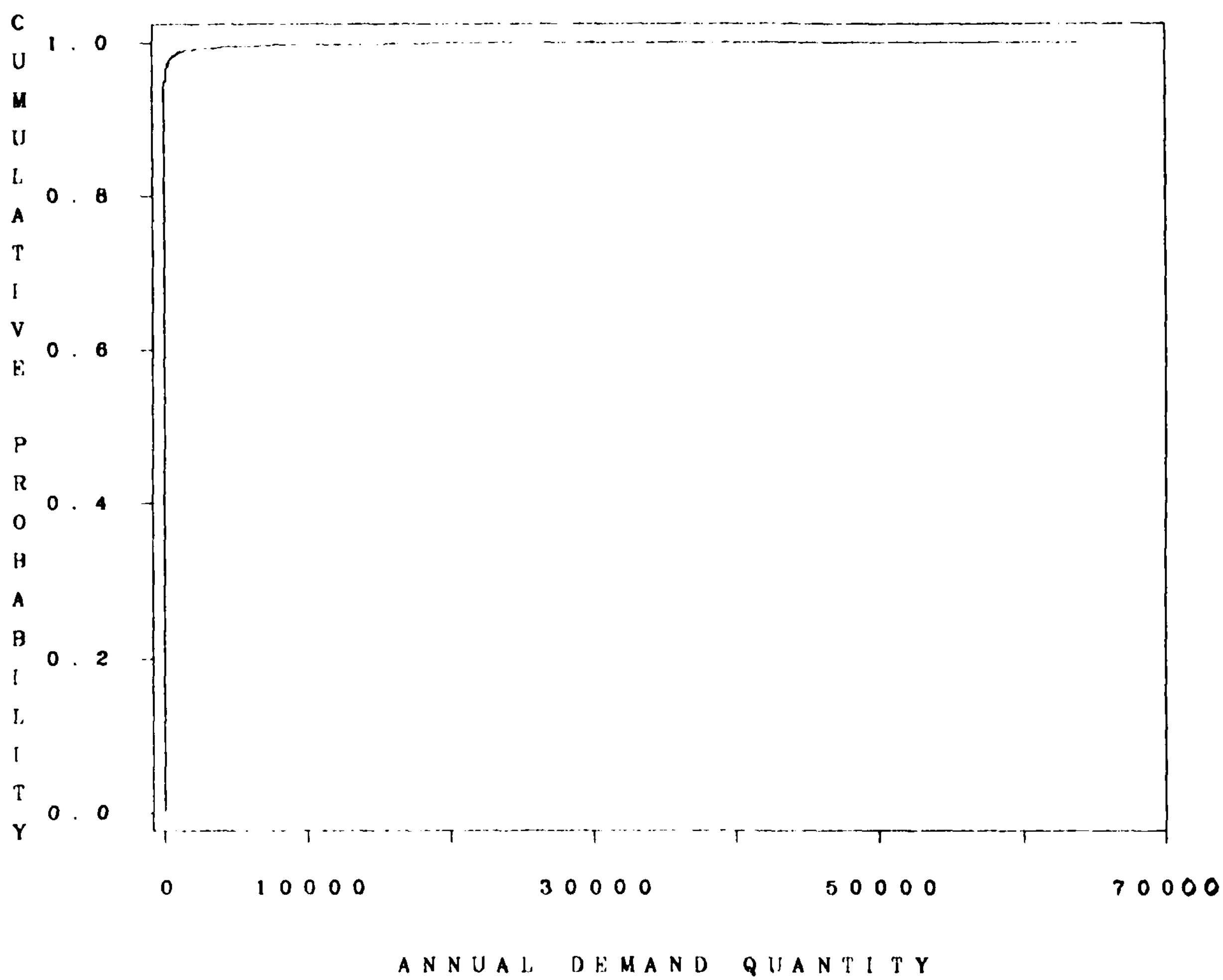
AVERAGE REQUISITION TYPE
PLOT OF EVERY 30TH POINT IN CUM DIST

ITEM CHARACTERISTIC # 8

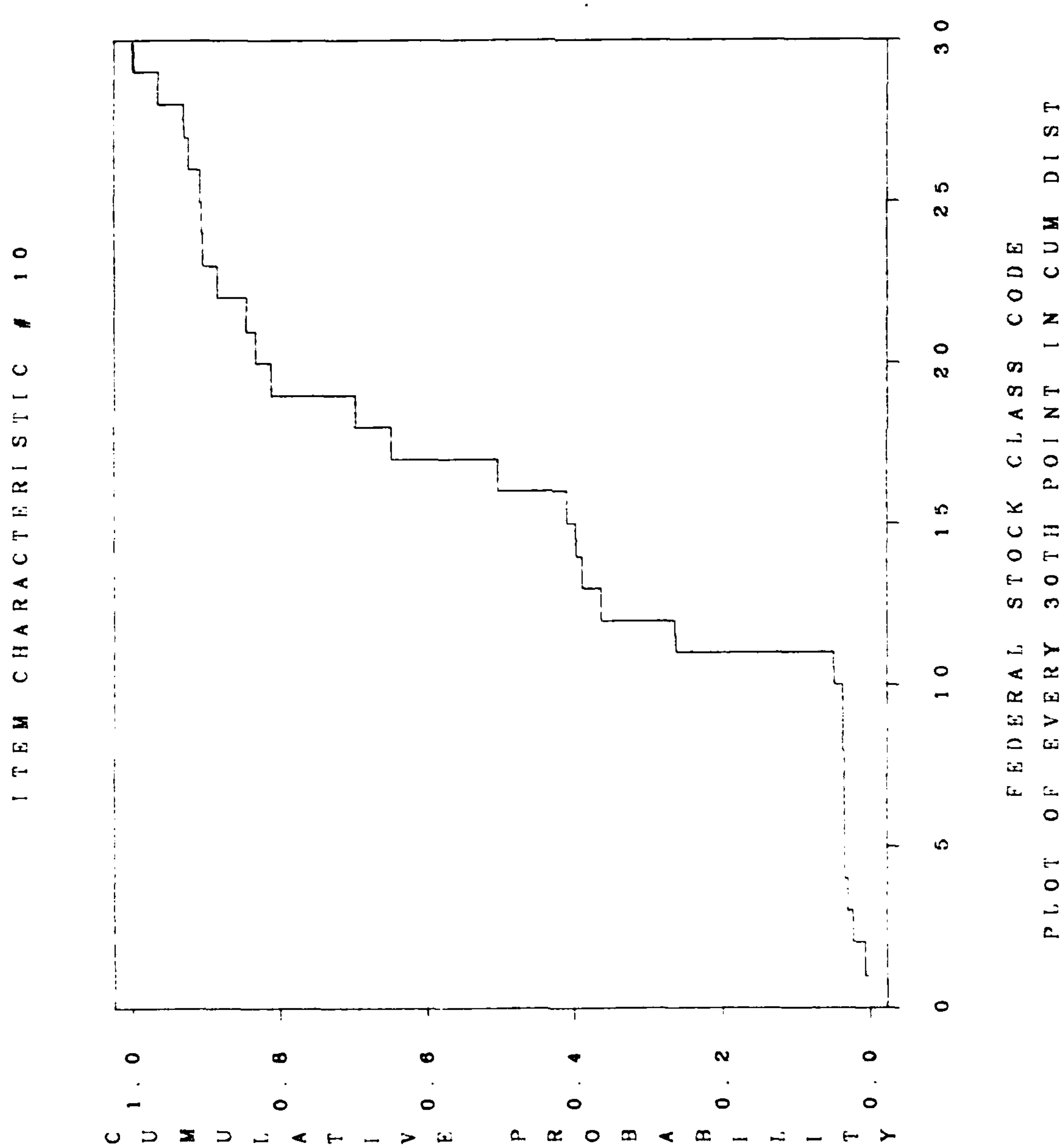


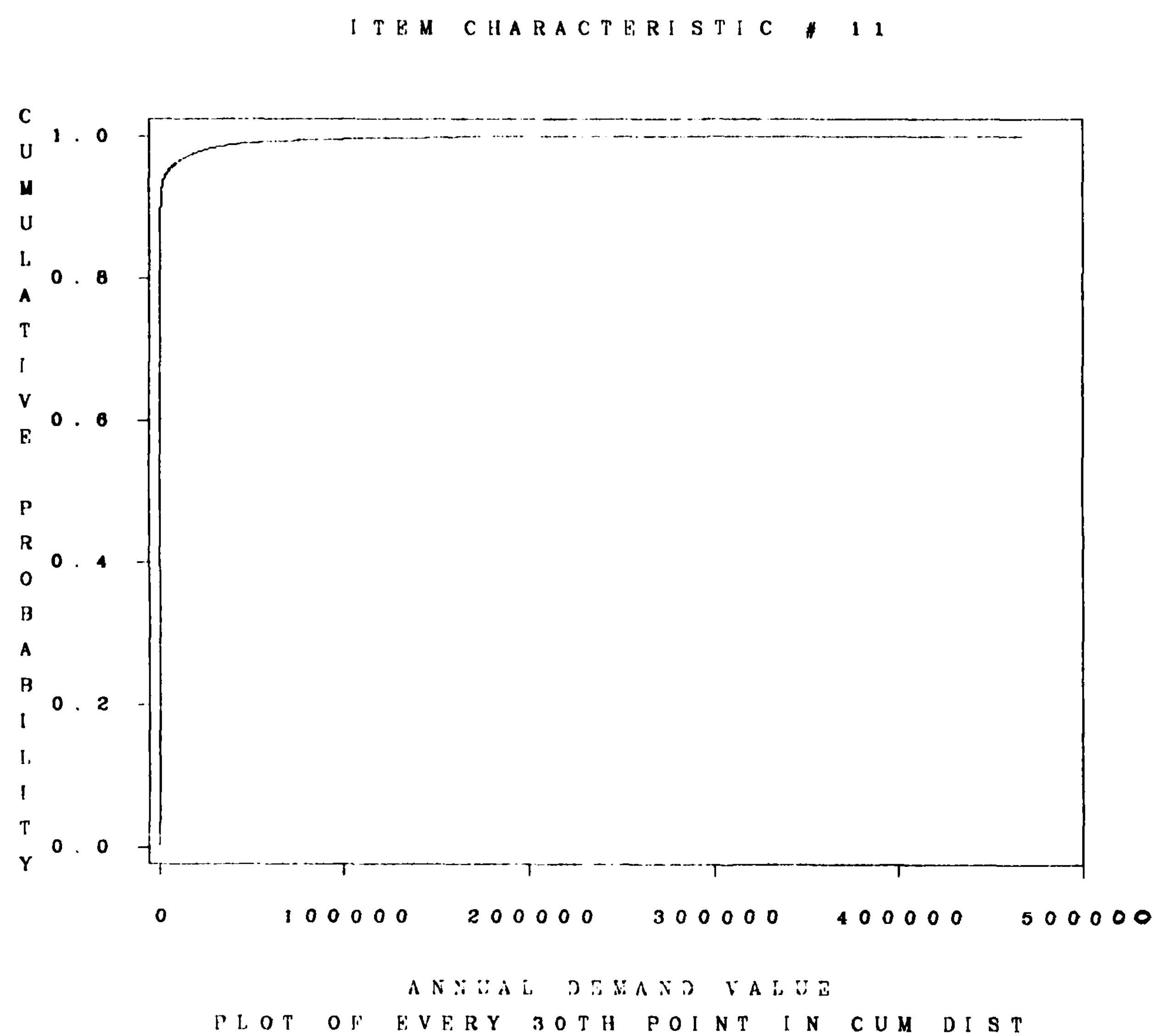
PLOT OF EVERY 30TH POINT IN CUM DIST

ITEM CHARACTERISTIC # 9



PLOT OF EVERY 30TH POINT IN CUM DIST


ITEM CHARACTERISTIC # 10
CUMULATIVE PROBABILITY
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
FEDERAL STOCK CLASS CODE
PLOT OF EVERY 30TH POINT IN CUM DIST


ITEM CHARACTERISTIC # 11
CUMULATIVE PROBABILITY
1.0
0.8
0.6
0.4
0.2
0.0
0
100000
200000
300000
400000
500000
ANNUAL DEMAND VALUE
PLOT OF EVERY 30TH POINT IN CUM DIST

Appendix C

FORTRAN Program Source Code

This appendix contains the FORTRAN source code for the four main programs used in testing item groupings. The first program listing gives the source for the grouping definition program, the second gives the source for the data collection program, the third gives the source for the distribution fitting program, and the final program listing gives the source for the simulation program.

GROUPING DEFINITION PROGRAM SOURCE CODE

```
      PROGRAM GRPINP
C
C     PROGRAM TO CREATE THE GROUPINGS FOR FITTING AND
C     SIMULATING DEMAND FOR THE DESC ITEM SAMPLE
C
C     POSSIBLE GROUPINGS ARE:
C
C       1) ANNUAL DEMAND FREQUENCY
C       2) ITEM CATEGORY (N-S, NSO, RL, RM, RH1, RH2)
C       3) MAXIMUM RQN SIZE
C       4) AVG RQN SIZE
C       5) DEMAND STABILITY (# OF CONSECUTIVE QUARTERS IN
C          CURRENT CATEGORY)
C       6) AVG PRIORITY
C       7) AVG FMS CODE
C       8) ITEM PRICE
C       9) ANNUAL DEMAND QUANTITY
C      10) FSC CODE
C      11) ANNUAL DEMAND VALUE
C
C     VARIABLE DEFINITIONS:
C       NAMES(1-11) - GROUPING VARIABLE NAMES
C       NTTL - ONE LINE TITLE DESCRIBING THIS SIMULATION RUN
C       IGROUP(1-11) - GROUPING VARIABLES FOR GROUPS 1 - 11
C       XLEVEL(100,11) - UP TO 100 CATEGORY CUTOFF POINTS FOR
C                        GROUPS 1 - 11
C       IGRP - THE NUMBER OF GROUPING CATEGORIES
C       ITGRP - THE TOTAL NUMBER OF GROUPINGS
C       ILEVEL(1-11) - NUMBER OF LEVELS WITHIN GROUPS 1 - 11
C       BLEVEL(11,1000) - GROUPING LEVEL ID'S FOR EACH OF ITGRP
C                        GROUPINGS
C       XVALUE(40) - INPUT VARIABLE BUFFER USED IN CNVXY
C                    ROUTINE
C       IFRSTD - FIRST DATE FOR WHICH DATA WILL BE COLLECTED
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT CHARACTER (N), LOGICAL (L)
      COMMON/GROUP/IGROUP(11),XLEVEL(100,11),IGRP,ILEVEL(11),ITGRP
      DIMENSION XVALUE(40),IWORK(11),BGROUP(11),KITEM(11)
      DIMENSION BLEVEL(11,1000),K(11)
      CHARACTER *25 NAMES(11)
      CHARACTER *80 NBUF,NTTL
      DATA NAMES/'DEMAND FREQUENCY','ITEM CATEGORY',
     +   'MAX RQN SIZE','AVG RQN SIZE','DEMAND STABILITY',
     +   'AVG PRIORITY','AVG FMS CODE','ITEM PRICE',
     +  'ANNUAL DEMAND QUANTITY','FSC CODE',
     +   'ANNUAL DEMAND VALUE'/
      IGRP = 0
C
```

GROUPING DEFINITION PROGRAM SOURCE CODE

```
C     OPEN THE OUTPUT FILES FOR THIS PROGRAM
C
      OPEN(1,FILE='GRPDEF.SIM',STATUS='NEW')
      OPEN(2,FILE='GRPID.SIM',STATUS='NEW')
C
C     OBTAIN THE USER INPUTS
C
  100 CONTINUE
      PRINT *,'CREATING SIMULATION GROUPINGS:'
      PRINT *,'ENTER ONE LINE TO IDENTIFY THIS RUN'
      READ(*,501) NTTL
  501 FORMAT(A80)
      PRINT *,'ENTER THE STARTING DATE FOR DATA COLLECTION ',
     +   '(E.G., 78274)'
      READ(*,501) NBUF
      CALL CNVXY(NBUF,XVALUE,ICNT)
      IFRSTD = IFIX(XVALUE(1))
C
C     NOW OBTAIN THE GROUPINGS FROM THE USER
C
C     PRINT A MENU OF THE POSSIBLE GROUPINGS
C
  200 CONTINUE
      PRINT *,'THE AVAILABLE GROUPING VARIABLES ARE:'
      DO 210 I = 1, 11
        WRITE(*,601) I,NAMES(I)
  601   FORMAT('     ',I2,') ',A25)
  210 CONTINUE
  220 CONTINUE
      PRINT *,'WHAT IS THE GROUPING VARIABLE? (0 TO QUIT)'
      READ(*,501) NBUF
      CALL CNVXY(NBUF,XVALUE,IVALS)
      IVAR = IFIX(XVALUE(1))
      IF(IVAR .LT. 1 .OR. IVAR .GT. 11) THEN
        IF(IVAR .EQ. 0) GO TO 300
        PRINT *,'**BAD GROUP NUMBER (ONLY 1 - 11 ARE POSSIBLE)'
        GO TO 220
      ENDIF
      IGRP = IGRP + 1
      IGROUP(IGRP) = IVAR
      ILEVEL(IGRP) = 0
      PRINT *,'ENTER UP TO 100 LEVELS FOR THIS VARIABLE'
      PRINT *,'   (EACH LEVEL CORRESPONDS TO AN UPPER VALUE'
      PRINT *,'    FOR THE DATA WITHIN THE LEVEL)'
      PRINT *,'   (ENTER A SINGLE -999 TO QUIT)'
  230 CONTINUE
      PRINT *,'?'
      READ(*,501) NBUF
      CALL CNVXY(NBUF,XVALUE,IVALS)
```

```
      IF(IVALS .EQ. 0) GO TO 230
      IF(XVALUE(1) .EQ. -999) GO TO 300
      DO 240 I = 1, IVALS
        ILEVEL(IGRP) = ILEVEL(IGRP) + 1
        XLEVEL(ILEVEL(IGRP),IGRP) = XVALUE(I)
  240 CONTINUE
      GO TO 230
  300 CONTINUE
C
C     WRITE OUT THE GROUP DEFINITION FILE 'GRPDEF.SIM'
C
C     FIRST OUTPUT THE RUN TITLE 'NTTL
C
      PRINT *, WRITING THE GROUP DEFINITIONS TO (GRPDEF.SIM)
      WRITE(1.101) NTTL
  101 FORMAT(1X,A80)
C
C     NOW OUTPUT THE FIRST DATE FOR DATA COLLECTION
C
      WRITE(1,161) IFRSTD
  161 FORMAT(I5)
C
C     OUTPUT THE TOTAL NUMBER OF GROUPING VARIABLES
C
      WRITE(1.102) IGRP
  102 FORMAT(I4)
      DO 310 I = 1, IGRP
C
C       OUTPUT GROUPING VARIABLE NUMBER FOR GROUPING I AND
C       # OF LEVELS FOR GROUPING I
C
        WRITE(1.103) IGROUP(I).ILEVEL(I)
  103   FORMAT(2I4)
C
C       OUTPUT UPPER VALUES FOR EACH LEVEL OF THIS
C       GROUPING
C
        DO 320 J = 1. ILEVEL(I)
          WRITE(1,104) XLEVEL(J,I)
  104     FORMAT(F12.4)
  320   CONTINUE
  310 CONTINUE
      CLOSE(1)
C
C     NOW OUTPUT THE GROUP ID FILE  GRPID.SIM
C
      DO 400 I = 1. IGRP
        K(I) = ILEVEL(I)
  400 CONTINUE
```

GROUPING DEFINITION PROGRAM SOURCE CODE

```
      PRINT *,'NOW WRITING THE GROUP ID FILE (GRPID.SIM)
      IF(IGRP .EQ. 1) THEN
        WRITE(2,201) (K1,K1=1,K(1))
201     FORMAT(I4)
      ELSEIF(IGRP .EQ. 2) THEN
        WRITE(2,202) ((K1,K2,K2=1,K(2)),K1=1,K(1))
202     FORMAT(2I4)
      ELSEIF(IGRP .EQ. 3) THEN
        WRITE(2,203) (((K1,K2,K3,K3=1,K(3)),K2=1,K(2)),K1=1,K(1))
203     FORMAT(3I4)
      ELSEIF(IGRP .EQ. 4) THEN
        WRITE(2,204) ((((K1,K2,K3,K4,K4=1,K(4)),
     +    K3=1,K(3)),K2=1,K(2)),K1=1,K(1))
204     FORMAT(4I4)
      ELSEIF(IGRP .EQ. 5) THEN
        WRITE(2,205) (((((K1,K2,K3,K4,K5,K5=1,K(5)),
     +    K4=1,K(4)),K3=1,K(3)),K2=1,K(2)),K1=1,K(1))
205     FORMAT(5I4)
      ELSEIF(IGRP .EQ. 6) THEN
        WRITE(2,206) ((((((K1,K2,K3,K4,K5,K6,K6=1,K(6)),
     +    K5=1,K(5)),K4=1,K(4)),K3=1,K(3)),K2=1,K(2)),K1=1,K(1))
206     FORMAT(6I4)
      ELSEIF(IGRP .EQ. 7) THEN
        WRITE(2,207) (((((((K1,K2,K3,K4,K5,K6,K7,
     +    K7=1,K(7)),K6=1,K(6)),K5=1,K(5)),K4=1,K(4)),
     +    K3=1,K(3)),K2=1,K(2)),K1=1,K(1))
207     FORMAT(7I4)
      ELSEIF(IGRP .EQ. 8) THEN
        WRITE(2,208) ((((((((K1,K2,K3,K4,K5,K6,K7,K8,
     +    K8=1,K(8)),K7=1,K(7)),K6=1,K(6)),
     +    K5=1,K(5)),K4=1,K(4)),K3=1,K(3)),K2=1,[illegible]
208     FORMAT(8I4)
      ELSEIF(IGRP .EQ. 9) THEN
        WRITE(2,[illegible] [illegible],3,[illegible]4,[illegible]5,[illegible]6,[illegible]7,[illegible]8,[illegible]9,
     +    [illegible]
     +    [illegible]
2[illegible]9     FORMAT(9I[illegible]
      ELSEIF(IGRP .EQ. 10) THEN
        WRITE(2,2[illegible]
     +    [illegible]
     +    [illegible]
     +    [illegible]
2[illegible]     FORMAT(10I4)
      ELSEIF(IGRP .EQ. 11) THEN
        WRITE(2,211) [illegible]
     +    [illegible]
     +    [illegible]
     +    [illegible]
2[illegible]     FORMAT(11I4)
```

```
      ENDIF
C
C     NOW READ BACK IN THE LEVELS FOR EACH GROUP SO THAT THEY CAN
C     BE WRITTEN USING BYTE SIZE VARIABLES TO SAVE SPACE
C
      REWIND 2
      ITGRP = 1
      DO 410 I = 1, IGRP
        ITGRP = ITGRP * ILEVEL(I)
  410 CONTINUE
      IF(ITGRP .GT. 1000) THEN
        PRINT *,'**ERROR - MAX ALLOWABLE NUMBER OF GROUPS IS 1000'
        PRINT *,'          YOU HAVE INPUT TOO MANY = ',ITGRP
        STOP
      ENDIF
      DO 420 I = 1, ITGRP
        READ(2,212) (K(II),II=1,IGRP)
        DO 430 II = 1, IGRP
          BLEVEL(II,I) = K(II)
  430   CONTINUE
  420 CONTINUE
      CLOSE(2,STATUS='DELETE')
      OPEN(2,FILE='GRPID.SIM',STATUS='NEW',FORM='UNFORMATTED',
     + ACCESS='SEQUENTIAL')
      DO 440 I = 1, ITGRP
        WRITE(2) (BLEVEL(II,I),II=1,IGRP)
  440 CONTINUE
      CLOSE(2)
      CLOSE(1)
      STOP
      END
      SUBROUTINE CNVX(NBUF,XVALUE,ICNT)
C
C     ROUTINE TO CONVERT AN INPUT CHARACTER BUFFER INTO
C     FROM 1 TO 40 REAL VALUES
C
      CHARACTER *80 NBUF,NFMT
      CHARACTER *2 NNUM(30)
      DIMENSION ISTR(3,40), XVALUE(40)
      DATA NNUM/'0','1','2','3','4','5','6','7','8','9',
     +  '10','11','12','13','14','15','16','17','18','19',
     +  '20','21','22','23','24','25','26','27','28','29'/
      DO 5 I = 1, 40
        DO 6 J = 1, 3
          ISTR(J,I) = 0
    6   CONTINUE
    5 CONTINUE
      JLEN = 0
      DO 10 I = 1, 80
```

```
        IF(NBUF(I:I) .EQ. ',') THEN
          NBUF(I:I) = ' '
        ENDIF
        IF(NBUF(I:I) .NE. ' ') THEN
          JLEN = I
        ENDIF
   10 CONTINUE
      ICNT = 0
      IF(JLEN .EQ. 0) THEN
        GO TO 999
      ENDIF
      JLEN = JLEN + 1
      LSPACE = .TRUE.
      DO 100 I = 1, JLEN
        IF(NBUF(I:I) .NE. ' ') THEN
          IF(LSPACE) THEN
            ICNT = ICNT + 1
            ISTR(1,ICNT) = I
          ELSE
            IF(NBUF(I:I) .EQ. '.') THEN
              ISTR(2,ICNT) = I
            ENDIF
          ENDIF
          LSPACE = .FALSE.
        ELSE
          IF(.NOT. LSPACE) THEN
            ISTR(3,ICNT) = I - 1
          ENDIF
          LSPACE = .TRUE.
        ENDIF
  100 CONTINUE
      IF(ICNT .EQ. 0) THEN
        GO TO 999
      ENDIF
      DO 200 I = 1, ICNT
        ILEN = (ISTR(3,I) - ISTR(1,I)) + 1
        IF(ISTR(2,I) .EQ. 0) THEN
          IDEC = 0
        ELSE
          IDEC = (ISTR(3,I) - ISTR(2,I)) + 1
        ENDIF
        NFMT = '(F' // NNUM(ILEN+1) // '.' // NNUM(IDEC+1)
     +         // ')'
        DO 210 J = 1, 10
          IF(NFMT(J:J) .EQ. ' ' .AND. NFMT(J+1:J+1) .NE. ' ') THEN
            NFMT(J:J) = NFMT(J+1:J+1)
            NFMT(J+1:J+1) = ' '
          ENDIF
  210   CONTINUE
```

```
      READ(NBUF(ISTR(1,I):ISTR(3,I)),NFMT) XVALUE(I)
200 CONTINUE
999 CONTINUE
    RETURN
    END
```

DATA COLLECTION PROGRAM SOURCE CODE

```
      PROGRAM GRPGET
C
C     GROUP ALL RQN DATA ACCORDING TO USER DEFINED CATEGORIES
C
C     POSSIBLE GROUPINGS ARE:
C
C     1) ANNUAL DEMAND FREQUENCY
C     2) ITEM CATEGORY (N-S, NSO, RL, RM, RH1, RH2)
C     3) MAXIMUM RQN SIZE
C     4) AVG RQN SIZE
C     5) DEMAND STABILITY (# OF CONSECUTIVE QUARTERS IN CURRENT
C        CATEGORY)
C     6) AVG PRIORITY
C     7) AVG FMS CODE
C     8) ITEM PRICE
C     9) ANNUAL DEMAND QUANTITY
C    10) FSC CODE
C    11) ANNUAL DEMAND VALUE
C
C     VARIABLE DEFINITIONS:
C       IPRI(3,1000)
C           (1,J) - COUNT OF PRIORITY I RQNS FOR JTH GROUPING
C           (2,J) - COUNT OF PRIORITY II RQNS FOR JTH GROUPING
C           (3,J) - COUNT OF PRIORITY III RQNS FOR JTH GROUPING
C       IFMS(3,1000)
C           (1,J) - COUNT OF NORMAL RQNS FOR JTH GROUPING
C           (2,J) - COUNT OF MAP/GRANT-AID RQNS FOR JTH GROUPING
C           (3,J) - COUNT OF FOREIGN MILITARY SALES RQNS FOR JTH GROUPIN
C       NAMES(1-11) - GROUPING VARIABLE NAMES
C       NTTL - ONE LINE TITLE DESCRIBING THIS SIMULATION RUN
C       NERROR(1-10) - DESCRIPTIONS OF ERROR COUNT VARIABLES
C       IERROR(1-10) - ERROR COUNTS
C       IGROUP(1-11) - GROUPING VARIABLES FOR GROUPS 1 - 11
C       RLEVEL(100,11) - UP TO 100 CATEGORY CUTOFF POINTS FOR
C                        GROUPS 1 - 11
C       IGRP - THE NUMBER OF GROUPING CATEGORIES
C       ITGRP - THE TOTAL NUMBER OF GROUPINGS
C       ILEVEL(1-11) - NUMBER OF LEVELS WITHIN GROUPS 1 - 11
C       GLEVEL(11,1000) - GROUPING LEVEL ID S FOR EACH OF ITGRP
C                        GROUPINGS
C       DSEED - RANDOM NUMBER SEED VALUE FOR IMSL VARIATE
C               GENERATOR
C       IDDMD(1-100) - DAILY DEMAND ARRAY
C       IBDATE(2,3) - STARTING AND ENDING DAYS FOR THE THREE
C                     MONTHS OF MISSING DATA (JUL 79, DEC 80,
C                     AND NOV 81)
C       NSTAT(3) - CHARACTER ARRAY CONTAINING SAMPLE SUMMARY
C                  NAMES FOR THE THREE TYPES OF DATA
C       NFN(3) - DATA FILE NAMES FOR THE THREE TYPES OF DATA
```

```
C        JITEM(1-41000) - GROUPING FOR EACH ITEM IN SAMPLE IN QTR 9
C        IFRSTD - FIRST DATE FOR WHICH DATA WILL BE COLLECTED
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  LOGICAL (L), DOUBLE PRECISION (D)
      COMMON/GROUP/IGROUP(11),XLEVEL(100,11),IGRP,ILEVEL(11),ITGRP
      COMMON/ITEM/BQTR(7500),IRSIZE(7500),JRDATE(7500),ITMCNT,
     +  BCODE1(7500),BCODE2(7500)
      COMMON/GRPDAT/IGCNTS(9,1000),IGOBS(3,9,1000)
      COMMON/SAVE/ISAVE(3,200000),ISVCNT,IWRT(3,1000),IWROLD(3,1000),
     +  ITDAT
      DIMENSION IDDMD(100),IBDATE(2,4)
      DIMENSION IERROR(10),JITEM(41000),XPROB(8)
      DIMENSION BLEVEL(11,1000),BLEV(11,9),KGROUP(9)
      DIMENSION IFDATA(9),JFDATA(9),BFDATA(9),IQDATE(2,9),BCAT(9)
      DIMENSION XITEM(9,11),BSIZE(3)
      DIMENSION IFMS(3,1000),IPRI(3,1000)
      DIMENSION IPOSDD(1000),ITOTDD(1000)
      DIMENSION IWORK(9),IWORK2(3,9)
      DIMENSION IQDAYS(9),ITGPOS(1000),ITGCNT(1000)
      CHARACTER *25 NAMES(11)
      CHARACTER *16 NSTAT(3)
      CHARACTER *3 NSTAT2(3)
      CHARACTER *35 NERROR(10)
      CHARACTER *80 NTTL
      DATA NAMES/'DEMAND FREQUENCY','ITEM CATEGORY',
     +  'MAX RQN SIZE','AVG RQN SIZE','DEMAND STABILITY',
     -  'AVG PRIORITY','AVG FMS CODE','ITEM PRICE',
     +  'ANNUAL DEMAND QUANTITY','FSC CODE','ANNUAL DEMAND VALUE'/
      DATA NERROR/'DEMAND QUANTITY LESS THAN 1',
     +  'FMS CODE OUT OF RANGE','PRIORITY CODE OUT OF RANGE',
     +  'DATE OF RQN OUT OF RANGE','CONVERTED DATE OUT OF RANGE',
     +  'INTERARRIVAL LESS THAN 0','QUARTER NUMBER EQUAL TO ZERO',
     +  'NO GROUPING FOUND FOR AN ITEM',
     +  'INTERARRIVAL USED WITH BAD QTRS',
     +  'INTERARRIVAL SAMPLES LOST'/
      DATA NSTAT/'DAILY DEMAND','REQUISITION SIZE',
     +  'INTERARRIVAL'/
      DATA NSTAT2/'OBS','PDF','CDF'/
      DATA IQDATE/274,365,366,455,456,546,639,730,731,821,912,1004,
     +  1097,1186,1187,1277,1278,1369/
      DATA IBDATE/547,577,822,912,1066,1096,1401,1430/
      DATA DSEED/9421294.0/
C
C     INPUT AND OUTPUT FILE DESCRIPTIONS:
C
C     INPUT FILES:
C
C        UNIT 1   GRPDEF.SIM  - CONTAINS GROUPING DEFINITIONS
```

```
C         UNIT 3) 'RQNNUM.DAT' - CONTAINS RQN HISTORY DATA
C         UNIT 4) 'GRPID.SIM' - CONTAINS CATEGORY LEVELS AND
C                  SAMPLE COUNTS FOR EACH OF ITGRP GROUPINGS
C         UNIT 8) 'CAT81.DAT' - ITEM CATEGORY DATA
C         UNIT 9) 'NEWF81.DAT' - FRAC DATA
C         UNIT 10) 'NSNALL.ID' - ITEM ID DATA
C
C       OUTPUT FILES:
C
C         UNIT 11) 'GRPCDF.SIM' - PRIORITY, FMS, AND DAILY DEMAND
C                   PROBABILITIES FOR EACH GROUPING
C         UNIT 15) ALL GROUPED DATA IS WRITTEN OUT USING THIS BUFFER
C         UNIT 2) 'ITEMID.SIM' - THE GROUPING FOR EACH ITEM IN QTR 9
C         UNIT 4) 'GRPID.SIM' - REWRITTEN TO ADD THE SAMPLE ITEM
C                  COUNTS FOR EACH GROUPING IN QTR 9
C
      WRITE(*,697)
  697 FORMAT('1CREATING SIMULATION GROUPING DATA FILES:')
C
C       READ THE GROUPING DEFINITIONS FOR THIS RUN
C
      OPEN(1,FILE='GRPDEF.SIM',STATUS='OLD')
      REWIND 1
C
C        NTTL' IS THE TITLE FOR THIS RUN
C
      READ(1.501) NTTL
  501 FORMAT(1X.A80)
      WRITE(*.698) NTTL
  698 FORMAT('0RUN TITLE = '.A80)
C
C       READ THE FIRST DATE FOR DATA COLLECTION
C
      READ(1.531) IFIRST
  531 FORMAT(I5)
C
C       CONVERT TO CONSECUTIVE DATE SINCE 78001
C
      I = IFIRST - 78000
      IYEAR = IYR/1000
      IDAY = I - (IYEAR * 1000)
      IFRSTD = (IYEAR * 365) + IDAY
C
C       ADJUST FOR LEAP YEAR IN 1980 IF PAST FEB28
C
      IF(IFRSTD .GT. 789) THEN
        IFRSTD = IFRSTD + 1
      ENDIF
      WRITE(*,696) IFRSTD, IFIRST
```

```
  696 FORMAT('0FIRST DATE FOR DATA COLLECTION = ',I5,
     +   '  JULIAN EQUIVALENT = ',I5)
C
C     READ THE NUMBER OF GROUPS 'IGRP'
C
      READ(1,502) IGRP
  502 FORMAT(I4)
C
C     FOR EACH GROUP, READ THE CORRESPONDING GROUPING VARIABLE
C     AND THE NUMBER OF LEVELS
C
      DO 125 I = 1, IGRP
        READ(1,503) IGROUP(I),ILEVEL(I)
  503   FORMAT(2I4)
C
C       FOR EACH LEVEL, READ THE CUTOFF VALUE
C
        DO 126 II = 1, ILEVEL(I)
          READ(1,504) XLEVEL(II,I)
  504     FORMAT(F12.4)
  126   CONTINUE
  125 CONTINUE
      CLOSE(1)
C
C     FIGURE TOTAL POSSIBLE GROUPINGS
C
      ITGRP = 1
      DO 130 I = 1, IGRP
        ITGRP = ITGRP * ILEVEL(I)
  130 CONTINUE
      WRITE(*,695) ITGRP
  695 FORMAT('0TOTAL GROUPINGS IN THIS RUN = ',I4)
C
C     READ THE GROUPING LEVEL VARIABLES FOR EACH GROUPING
C
      OPEN(4,FILE='GRPID.SIM',STATUS='OLD',
     +  FORM='UNFORMATTED',ACCESS='SEQUENTIAL')
      REWIND 4
      DO 140 I = 1, ITGRP
        READ(4) (BLEVEL(II,I),II=1,IGRP)
  140 CONTINUE
      CLOSE(4)
C
C     WRITE OUT THE GROUPING VARIABLE LEVELS FOR EACH GROUPING
C
      DO 190 I = 1, ITGRP
        WRITE(*,611) I
  611   FORMAT('0DEFINITION FOR GROUPING # ',I4,
        WRITE(*,612)
```

```
612   FORMAT('  LEVELS FOR THIS GROUPING ARE: ./)
      DO 185 II = 1, IGRP
        IF(BLEVEL(II,I) .EQ. 1) THEN
          WRITE(*,613) II,NAMES(IGROUP(II)),
     +      XLEVEL(BLEVEL(II,I),II)
613       FORMAT(1X,I1,12X,6X,A35,' .LE. ',F12.3)
        ELSE
          WRITE(*,614) II,XLEVEL(BLEVEL(II,I)-1,II),
     +      NAMES(IGROUP(II)),XLEVEL(BLEVEL(II,I),II)
614       FORMAT(1X,I1,F12.3,' .LT. ',A35,' .LE. ',F12.3)
        ENDIF
185   CONTINUE
190 CONTINUE
    WRITE(*,615)
615 FORMAT('1DATA COLLECTION SUMMARY:')
C
C   ZERO OUT NECESSARY STORAGE
C
    ITDAT = 0
    ISVCNT = 0
    DO 191 I = 1, 3
      DO 188 II = 1, 1000
        IWRT(I,II) = 0
        IWROLD(I,II) = 0
188   CONTINUE
191 CONTINUE
    DO 192 I = 1, 9
      DO 193 II = 1, ITGRP
        IGCNTS(I,II) = 0
        DO 194 III = 1, 3
          IGOBS(III,I,II) = 0
194     CONTINUE
193   CONTINUE
192 CONTINUE
    DO 195 II = 1, 10
      IERROR(II) = 0
195 CONTINUE
C
C   ZERO OUT THE ITEM COUNTS FOR TOTAL GROUP COUNTS AND
C   TOTAL POSITIVE COUNTS
C
    DO 143 I = 1, ITGRP
      ITGPOS(I) = 0
      ITGCNT(I) = 0
143 CONTINUE
C
C   OPEN THE REQUISITION HISTORY DATA FILE
C
    OPEN(3,FILE='RQNNUM.DAT',STATUS='OLD')
```

```
     + FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 3
C
C     OPEN THE ITEM CATEGORY DATA FILE
C
      OPEN(8,FILE='CAT81.DAT',STATUS='OLD',
     + FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 8
C
C     OPEN THE FRACTIONATION HISTORY DATA FILE
C
      OPEN(9,FILE='NEWF81.DAT',STATUS='OLD',
     + FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 9
C
C     OPEN THE ITEM ID DATA FILE
C
      OPEN(10,FILE='NSNALL.ID',STATUS='OLD',
     + FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 10
C
C     COMPUTE NUMBER OF DAYS IN EACH QUARTER
C
      DO 144 I = 1, 9
        IQDAYS(I) = (IQDATE(2,I) - IQDATE(1,I)) + 1
  144 CONTINUE
C
C     READ THE DATA FOR EACH ITEM AND GROUP IT ACCORDING TO THE
C     USER DEFINED GROUPING VARIABLES AND LEVELS
C
      DO 200 I = 1, 40909
        ITMCNT = 0
        IF(ITDAT .GT. 2000000) THEN
          STOP
        ENDIF
        READ(8) (BCAT(II),II=1,3),BJUN(1),(BCAT(II),II=4,6),
     +    BJUN(2),(BCAT(II),II=7,9),BJUN(3)
        DO 210 II = 1, 9
          IVAL = BCAT(II)
          XITEM(II,2) = FLOAT(IVAL)
  210   CONTINUE
C
C       READ THE # OF RONS AND # OF FRAC ENTRIES FOR THIS ITEM
C
        READ(10) BFSC,JRONS,BFR81
        IVAL = BFSC
        DO 220 II = 1, 9
          XITEM(II,10) = FLOAT(IVAL)
  220   CONTINUE
```

```
      IF(BFR81 .EQ. 0) THEN
        DO 230 II = 1, 9
          XITEM(II,1) = 0.0
          XITEM(II,9) = 0.0
          XITEM(II,8) = 0.0
          XITEM(II,11) = 0.0
230     CONTINUE
      ELSE
        READ(9) (BSIZE(II),II=1,3)
        DO 240 II = 1, 3
          IF(BSIZE(II) .EQ. 1) THEN
            READ(9) (BFDATA(III),III=1,9)
            DO 250 III = 1, 9
              IFDATA(III) = BFDATA(III)
250         CONTINUE
          ELSEIF(BSIZE(II) .EQ. 2) THEN
            READ(9) (JFDATA(III),III=1,9)
            DO 260 III = 1, 9
              IFDATA(III) = JFDATA(III)
260         CONTINUE
          ELSE
            READ(9) (IFDATA(III),III=1,9)
          ENDIF
          IF(II .EQ. 1) THEN
            DO 270 III = 1, 9
              XITEM(III,1) = FLOAT(IFDATA(III))
270         CONTINUE
          ELSEIF(II .EQ. 2) THEN
            DO 280 III = 1, 9
              XITEM(III,9) = FLOAT(IFDATA(III))
280         CONTINUE
          ELSE
            DO 290 III = 1, 9
              XITEM(III,8) = FLOAT(IFDATA(III))/100.0
              XITEM(III,11) = XITEM(III,9) + XITEM(III,8)
290         CONTINUE
          ENDIF
240     CONTINUE
      ENDIF
      IF(JRGNS .EQ. 0) THEN
        DO 300 II = 1, 9
          XITEM(II,3) = 0.0
          XITEM(II,4) = 0.0
          XITEM(II,6) = 0.0
          XITEM(II,7) = 0.0
300     CONTINUE
      ELSE
C
C       READ EACH RGN HISTORY RECORD FOR THE ITH ITEM
```

DATA COLLECTION PROGRAM SOURCE CODE

```
C
          DO 320 II = 1, JRQNS
            READ(3) IQTY,BFMS,BPRI,JDATE
            IYR = JDATE/1000
            IYEAR = IYR + 78
            IDAY = JDATE - (IYR * 1000)
C
C           CHECK FOR DATA ERRORS
C
            IF(IQTY .EQ. 0) THEN
            IERROR(1) = IERROR(1) + 1
            GO TO 320
            ENDIF
            IF((BFMS .LT. 0) .OR. (BFMS .GT. 2)) THEN
              IERROR(2) = IERROR(2) + 1
              GO TO 320
            ENDIF
            IF((BPRI .LT. 1) .OR. (BPRI .GT. 15)) THEN
              IERROR(3) = IERROR(3) + 1
              GO TO 320
            ENDIF
            IF((IYEAR .LT. 78) .OR. (IYEAR .GT. 81)) THEN
              IERROR(4) = IERROR(4) + 1
              GO TO 320
            ENDIF
            IF((IDAY .LT. 1) .OR. (IDAY .GT. 366)) THEN
              IERROR(4) = IERROR(4) + 1
              GO TO 320
            ENDIF
C
C           CONVERT JULIAN DATE TO NUMBER OF CONSECUTIVE
C           DAYS STARTING WITH JAN 1, 1978 AS 1
C
            IDATE = IDAY + (365 * IYR)
C
C           ADJUST DATE FOR LEAP YEAR IN 1980 IF PAST FEB 28
C
            IF(IDATE .GT. 789) THEN
              IDATE = IDATE + 1
            ENDIF
            IF((IDATE.LT.IFRSTD) .OR. (IDATE.GT.1461)) THEN
              IERROR(5) = IERROR(5) + 1
              GO TO 320
            ENDIF
C
C           NO DATA ERRORS WERE DETECTED SO SAVE DATA
C
            IQTR = 0
            DO 330 III = 1, 9
```

```
            IF(IDATE .GE. IQDATE(1,III) .AND. IDATE .LE.
     +        IQDATE(2,III)) THEN
              IQTR = III
            ENDIF
 330      CONTINUE
          IF(IQTR .NE. 0) THEN
            ITMCNT = ITMCNT + 1
            BQTR(ITMCNT) = IQTR
            IRSIZE(ITMCNT) = IQTY
            JRDATE(ITMCNT) = IDATE
            IF(BPRI .LE. 3) THEN
              BCODE1(ITMCNT) = 1
            ELSEIF(BPRI .LE. 8) THEN
              BCODE1(ITMCNT) = 2
            ELSE
              BCODE1(ITMCNT) = 3
            ENDIF
            BCODE2(ITMCNT) = BFMS
          ELSE
            IERROR(7) = IERROR(7) + 1
          ENDIF
 320    CONTINUE
        IF(ITMCNT .EQ. 0) THEN
          DO 340 II = 1, 9
            XITEM(II,3) = 0.0
            XITEM(II,4) = 0.0
            XITEM(II,6) = 0.0
            XITEM(II,7) = 0.0
 340      CONTINUE
        ELSE
C
C         COMPUTE VALUES FOR AVG RON, MAX RON, AVG PRI, AND
C         AVG FMS FOR EACH QUARTER
C
          DO 400 II = 1, 9
            XTOT1 = 0.0
            XTOT2 = 0.0
            XTOT3 = 0.0
            XMAX = 0.0
            XCNT = 0.0
            DO 410 III = 1, ITMCNT
              IF(BQTR(III) .EQ. II) THEN
                XTOT1 = XTOT1 + FLOAT(IRSIZE(III))
                IVAL = BCODE1(III)
                XTOT2 = XTOT2 + FLOAT(IVAL)
                IVAL = BCODE2(III)
                XTOT3 = XTOT3 + FLOAT(IVAL)
                XVAL = FLOAT(IRSIZE(III))
                IF(XVAL .GT. XMAX) THEN
```

```
                XMAX = XVAL
              ENDIF
              XCNT = XCNT + 1
            ENDIF
  410     CONTINUE
          IF(XCNT .EQ. 0.0) THEN
            XITEM(II,3) = 0.0
            XITEM(II,4) = 0.0
            XITEM(II,6) = 0.0
            XITEM(II,7) = 0.0
          ELSE
            XITEM(II,3) = XMAX
            XITEM(II,4) = XTOT1/XCNT
            XITEM(II,6) = XTOT2/XCNT
            XITEM(II,7) = XTOT3/XCNT
          ENDIF
  400   CONTINUE
      ENDIF
    ENDIF
C
C       COMPUTE THE DEMAND STABILITY FACTOR FOR EACH QUARTER
C
        DO 415 II = 1, 9
          XITEM(II,5) = 1.0
          IF(II .GT. 1) THEN
            IF(BCAT(II) .EQ. BCAT(II-1)) THEN
              XITEM(II,5) = XITEM(II,5) + XITEM(II-1,5)
            ENDIF
          ENDIF
  415   CONTINUE
C
C       THE NEXT STEP IS TO FIGURE OUT WHICH GROUPING THIS ITEM
C       BELONGS TO FOR EACH OF THE QUARTERS
C
        DO 420 II = 1, 9
C
C         DETERMINE THE GROUPING VARIABLE LEVELS FOR THIS ITEM
C
          DO 430 IG = 1, IGRP
            IP = IGROUP(IG)
            DO 440 IL = 1, ILEVEL(IG)
              IF(IL .EQ. 1) THEN
                IF(XITEM(II,IP) .LE. XLEVEL(IL,IG)) THEN
                  BLEV(IG,II) = IL
                ENDIF
              ELSE
                IF(XITEM(II,IP) .GT. XLEVEL(IL-1,IG) .AND.
     +            XITEM(II,IP) .LE. XLEVEL(IL,IG))  THEN
                  BLEV(IG,II) = IL
```

```
              ENDIF
            ENDIF
  440     CONTINUE
  430   CONTINUE
C
C       NOW FIGURE OUT WHICH GROUP THE ITEM BELONGS IN
C
        KGROUP(II) = 0
        DO 450 IT = 1, ITGRP
          LGOOD = .TRUE.
          DO 460 IG = 1, IGRP
            IF(BLEV(IG,II) .NE. BLEVEL(IG,IT)) THEN
              LGOOD = .FALSE.
            ENDIF
  460     CONTINUE
          IF(LGOOD) THEN
            KGROUP(II) = IT
          ENDIF
  450   CONTINUE
        IF(KGROUP(II) .EQ. 0) THEN
          IERROR(8) = IERROR(8) + 1
        ENDIF
  420 CONTINUE
C
C     UPDATE THE GROUP ITEM COUNTS
C
      DO 470 II = 1, 9
        IGCNTS(II,KGROUP(II)) = IGCNTS(II,KGROUP(II)) + 1
  470 CONTINUE
      JITEM(I) = KGROUP(9)
      ITGCNT(KGROUP(1)) = ITGCNT(KGROUP(1)) + 1
      IF(ITMCNT .EQ. 0) THEN
        GO TO 554
      ELSE
        ITGPOS(KGROUP(1)) = ITGPOS(KGROUP(1)) + 1
      ENDIF
C
C     NOW SAVE THE REQUISITION SIZE DATA FOR THIS ITEM
C
      DO 500 II = 1, ITMCNT
        IQ = BQTR(II)
        CALL SAVDAT(1,2,KGROUP(IQ),IRSIZE(II),IQ,.FALSE.
        IPRI(BCODE1(II),KGROUP(IQ)) = IPRI(BCODE1(II),
     -    KGROUP(IQ)) + 1
        IFMS(BCODE2(II)+1,KGROUP(IQ)) =
     +    IFMS(BCODE2(II)+1,KGROUP(IQ)) + 1
  500 CONTINUE
C
C     NOW SAVE THE DAILY DEMAND DATA FOR THIS ITEM
```

```
C
      DO 510 II = 1, 9
C
C       ZERO OUT THE DAILY DEMAND ARRAY
C
        DO 520 III = 1, IQDAYS(II)
          IDDMD(III) = 0
  520   CONTINUE
        DO 530 III = 1, ITMCNT
          IF(JRDATE(III) .GE. IQDATE(1,II) .AND. JRDATE(III) .LE.
     +      IQDATE(2,II)) THEN
            IPOS = (JRDATE(III) - IQDATE(1,II)) + 1
            IDDMD(IPOS) = IDDMD(IPOS) + IRSIZE(III)
          ENDIF
  530   CONTINUE
C
C       COUNT THE POSITIVE ENTRIES AND SAVE THEM
C
        IPOS = 0
        DO 540 III = 1, IQDAYS(II)
          IF(IDDMD(III) .GT. 0) THEN
            IPOS = IPOS + 1
            CALL SAVDAT(I,1,KGROUP(II),IDDMD(III),II,.FALSE.)
          ENDIF
  540   CONTINUE
C
C       ADJUST COUNTERS FOR GENERATION OF DAILY DEMAND PROBABILITIES
C
        IPOSDD(KGROUP(II)) = IPOSDD(KGROUP(II)) + IPOS
  510 CONTINUE
C
C     NOW SAVE THE INTERARRIVAL DATA FOR THIS ITEM
C
      IF(ITMCNT .EQ. 1) THEN
C
C       GENERATE A RANDOM ARRIVAL BETWEEN 1 AND 321 DAYS
C       AND USE AS NEXT ARRIVAL FOR THIS ITEM
C
        CALL GGUBS(DSEED,1,XUNIF)
        XDAYS = 1.0 + (XUNIF * 321.0)
        IDAYS = (1369 - JRDATE(1)) - INT(XDAYS)
        IQ = SQTR(1)
        CALL SAVDAT(I,2,KGROUP(IQ),IDAYS,IQ,.FALSE.)
        GO TO 554
      ENDIF
      DO 550 II = 2, ITMCNT
        IDAYS = JRDATE(II) - JRDATE(II-1)
        IF(IDAYS .LT. 0) THEN
          IERROR(6) = IERROR(6) + 1
```

```
          ELSE
            LGOOD = .TRUE.
            DO 560 III = 1, 4
              IF(JRDATE(II-1) .LT. IBDATE(1,III) .AND.
     +          JRDATE(II) .GT. IBDATE(2,III)) THEN
                LGOOD = .FALSE.
              ENDIF
  560       CONTINUE
            IF(LGOOD .OR. ITMCNT .LE. 2) THEN
              IF(.NOT. LGOOD) THEN
                IERROR(9) = IERROR(9) + 1
              ENDIF
              IQ = BQTR(II-1)
              CALL SAVDAT(I,3,KGROUP(IQ),IDAYS,IQ,.FALSE.)
            ELSE
              IERROR(10) = IERROR(10) + 1
            ENDIF
          ENDIF
  550   CONTINUE
  554   CONTINUE
C
C       ADJUST COUNTER FOR TOTAL POSSIBLE DAYS OF
C       POSITIVE DAILY DEMAND
C
        DO 555 II = 1, 9
          ITOTDD(KGROUP(II)) = ITOTDD(KGROUP(II)) + IQDAYS(II)
  555   CONTINUE
  200 CONTINUE
C
C     DO THE FINAL DATA SAVE
C
      CALL SAVDAT(1,1,1,1,1,.TRUE.)
C
C     WRITE OUT 'ITEMID.SIM' FILE
C
      OPEN(2,FILE='ITEMID.SIM',STATUS='NEW',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL')
      DO 570 I = 1, 40909
        WRITE(2) JITEM(I)
  570 CONTINUE
C
C     WRITE OUT THE PRIORITY, DAILY DEMAND, AND FMS STATUS DATA
C     FOR EACH GROUPING
C
      OPEN(11,FILE='GRPCDF.SIM',STATUS='NEW',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL')
      DO 700 I = 1, ITGRP
        WRITE(*,620) I
  620   FORMAT('0SUMMARY FOR GROUP ',I4)
```

```
      IPTOT = IPRI(1,I) + IPRI(2,I) + IPRI(3,I)
      IFTOT = IFMS(1,I) + IFMS(2,I) + IFMS(3,I)
      DO 710 II = 1, 3
        IF(IPTOT .NE. 0) THEN
          XPROB(II) = FLOAT(IPRI(II,I))/FLOAT(IPTOT)
        ELSE
          XPROB(II) = 0.0
        ENDIF
        IF(IFTOT .NE. 0.0) THEN
          XPROB(II+4) = FLOAT(IFMS(II,I))/FLOAT(IFTOT)
        ELSE
          XPROB(II+4) = 0.0
        ENDIF
710   CONTINUE
      WRITE(*,621)
621   FORMAT('   REQUISITION PRIORITY:',/,
     +  19X,'I',8X,'II',7X,'III',5X,'TOTAL')
      WRITE(*,622) NSTAT2(1),(IPRI(II,I),II=1,3),IPTOT
622   FORMAT(5X,A3,2X,4I10)
      XPROB(4) = 1.0
      WRITE(*,623) NSTAT2(2),(XPROB(II),II=1,4)
623   FORMAT(5X,A3,2X,4F10.7)
      XPROB(2) = XPROB(2) + XPROB(1)
      XPROB(3) = 1.0
      WRITE(*,623) NSTAT2(3),(XPROB(II),II=1,3)
      WRITE(*,624)
624   FORMAT('   REQUISITION TYPE:',/,
     +  14X,'NORMAL',3X,'MAP/G-A',7X,'FMS',5X,'TOTAL')
      WRITE(*,622) NSTAT2(1),(IFMS(II,I),II=1,3),IFTOT
      XPROB(8) = 1.0
      WRITE(*,623) NSTAT2(2),(XPROB(II),II=5,8)
      XPROB(6) = XPROB(6) + XPROB(5)
      XPROB(7) = 1.0
      WRITE(*,623) NSTAT2(3),(XPROB(II),II=5,7)
      WRITE(*,625) IPOSDD(I),ITOTDD(I)
625   FORMAT('   DAILY DEMAND:',/,
     +  5X,'TOTAL POSSIBLE DAYS =      ',I3,/,
     +  5X,'NUMBER OF POSITIVE DAYS =  ',I3)
      IF(ITOTDD(I) .EQ. 0) THEN
        XPROB(8) = 0.0
      ELSE
        XPROB(8) = FLOAT(IPOSDD(I))/FLOAT(ITOTDD(I))
      ENDIF
      WRITE(*,626) XPROB(8)
626   FORMAT(5X,'PROBABILITY OF POSITIVE DEMAND =  ',F10.3)
      WRITE(11) (XPROB(II),II=1,3),(XPROB(II),II=5,8)
700 CONTINUE
C
C     OUTPUT THE ERROR SUMMARY
```

```
C
      WRITE(*,627)
  627 FORMAT('0ERROR SUMMARY:')
      DO 720 I = 1, 10
        WRITE(*,628) NERROR(I),IERROR(I)
  628   FORMAT(3X,'ERROR COUNT DUE TO ',A35,' = ',I10)
  720 CONTINUE
C
C     OUTPUT DATA COLLECTION SUMMARY FOR EACH GROUP
C
      WRITE(*,629)
  629 FORMAT('0DATA COLLECTION SUMMARY:')
      WRITE(*,630)
  630 FORMAT('0  ITEM COUNTS:')
      WRITE(*,631) (I,I=1,9)
  631 FORMAT(5X,'GROUP',9(2X,'QTR ',I1),'    TOTAL')
      DO 729 I = 1, 9
        IWORK(I) = 0
  729 CONTINUE
      DO 730 I = 1, ITGRP
        ITOT = 0
        DO 735 II = 1, 9
          ITOT = ITOT + IGCNTS(II,I)
          IWORK(II) = IWORK(II) + IGCNTS(II,I)
  735   CONTINUE
        WRITE(*,632) I,(IGCNTS(II,I),II=1,9),ITOT
  632   FORMAT(5X,I5,10I7)
  730 CONTINUE
      WRITE(*,761) (IWORK(I),I=1,9)
  761 FORMAT(5X,'TOTAL',9I7)
      WRITE(*,633)
  633 FORMAT('0  OBSERVATION COUNTS:')
      WRITE(*,634) (I,I=1,9)
  634 FORMAT(5X,'GROUP',2X,'DISTRIBUTION',4X,9(2X,'QTR ',I1),
     -       'TOTAL')
      DO 739 I = 1, 3
        DO 738 II = 1, 9
          IWORK2(I,II) = 0
  738   CONTINUE
  739 CONTINUE
C
C     OUTPUT THE TOTAL OBSERVATIONS FOR EACH GROUP FOR EACH
C     DISTRIBUTION TO 'GRPOBS.DAT'
C
      OPEN(4,FILE='GRPOBS.DAT',STATUS='NEW',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL')
      DO 740 I = 1, ITGRP
        DO 750 II = 1, 3
          ITOT = 0
```

```
          DO 760 III = 1, 9
            ITOT = ITOT + IGOBS(II,III,I)
            IWORK2(II,III) = IWORK2(II,III) + IGOBS(II,III,I)
  760     CONTINUE
          WRITE(*,635) I,NSTAT(II),(IGOBS(II,III,I),III=1,9),ITOT
  635     FORMAT(5X,I5,2X,A16,10I7)
          WRITE(4) ITOT
  750   CONTINUE
  740 CONTINUE
      CLOSE(4)
      DO 741 I = 1, 3
        WRITE(*,672) NSTAT(I),(IWORK2(I,II),II=1,9)
  672   FORMAT(5X,'TOTAL',2X,A16,9I7)
  741 CONTINUE
C
C     OUTPUT NEW 'GRPID.SIM' DATA FILE
C
      OPEN(4,FILE='GRPID.SIM',STATUS='NEW',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL')
      DO 770 I = 1, ITGRP
        WRITE(4) (BLEVEL(II,I),II=1,IGRP),IGCNTS(9,I)
  770 CONTINUE
      CLOSE(4)
C
C     OUTPUT THE PROBABILITY OF POSITIVE DEMAND FOR EACH GROUP
C     TO 'GRPPOS.DAT'
C
      OPEN(4,FILE='GRPPOS.DAT',STATUS='NEW',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL')
      DO 771 I = 1, ITGRP
        IF(ITGCNT(I) .GT. 0) THEN
          X = FLOAT(ITGPOS(I))/FLOAT(ITGCNT(I))
        ELSE
          X = 0.0
        ENDIF
        WRITE
  771 CONTINUE
      CLOSE(4)
      CLOSE(7)
      CLOSE(8)
      CLOSE(9)
      CLOSE(10[illegible]
      CLOSE(11)
      STOP
      END
      SUBROUTINE SAVDAT(ITM,ITYPE,IGROUP,IDATA,IOTR,LSAVE
C
C     ROUTINE TO DO THE DATA SAVING FUNCTION
C
```

```
C      PARAMETERS:
C        ITM - THE CURRENT ITM NUMBER
C        ITYPE - THE DATA TYPE
C          1 = DAILY DEMAND
C          2 = REQUISITION SIZE
C          3 = INTERARRIVAL
C        KGROUP - THE GROUP TO WHICH THIS DATA BELONGS
C        IDATA - THE DATA ELEMENT
C        IQTR - THE QUARTER NUMBER FROM WHICH THIS DATA COMES
C        LSAVE - FLAGS WHETHER TO FORCE A DATA SAVE TO GROUPING FILES
C          .TRUE. = FORCE A SAVE
C          .FALSE. = DO NOT FORCE A SAVE
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     -  DOUBLE PRECISION (D), CHARACTER (N)
      COMMON/GROUP/IGROUP(11),KLEVEL(100,11),IGRP,ILEVEL(11),ITGRP
      COMMON/SAVE/ISAVE(3,200000),ISVCNT,IWRT(3,1000),IWROLD(3,1000),
     +  ITDAT
      COMMON/SAVE2/ICTOFF(10000),ICTNUM(10000),ICUT
      COMMON/GRPDAT/IGCNTS(9,1000),IGOBS(3,9,1000)
      CHARACTER *10 NFN(3),NFILE
      DATA NFN/'GR0000.DDD','GR0000.SIZ','GR0000.ARR'/
      IF(LSAVE) GO TO 10
      ISVCNT = ISVCNT + 1
      ISAVE(1,ISVCNT) = ITYPE
      ISAVE(2,ISVCNT) = KGROUP
      ISAVE(3,ISVCNT) = IDATA
      IGOBS(ITYPE,IQTR,KGROUP) = IGOBS(ITYPE,IQTR,KGROUP) + 1
C
C      DO THE DATA SAVE IF ISVCNT HAS REACHED 200000 OR IF LSAVE IS
C      TRUE
C
      IF(ISVCNT .LT. 200000) GO TO 999
   10 CONTINUE
      IF(ISVCNT .EQ. 0) GO TO 999
      ITDAT = ITDAT + ISVCNT
      WRITE(*,500) ITDAT,ITM
  500 FORMAT(' DOING A DATA SAVE. DATA COUNT = ',I10,
     -             ' CURRENT ITEM NUMBER = ',I5,/,
     -    ' IGROUP    DAILY     SIZE      ARR  TOTAL DAILY    TOTAL SIZE ',
     +          'TOTAL ARR ')
      DO 100 I = 1, ITGRP
        DO 110 II = 1, 3
          IWRT(II,I) = 0
  110   CONTINUE
        LWRITE = .FALSE.
        DO 120 II = 1, ISVCNT
          IF(ISAVE(2,II) .EQ. I) THEN
            IWRT(ISAVE(1,II),I) = IWRT(ISAVE(1,II),I) + 1
```

```
          ENDIF
  120   CONTINUE
        DO 170 II = 1, 3
          IF(IWRT(II,I) .GT. 0) THEN
            LWRITE = .TRUE.
            WRITE(NFILE,101) I
  101       FORMAT('GR',I4,'.DDD')
            DO 140 III = 3, 6
              IF(NFILE(III:III) .EQ. ' ') THEN
                NFILE(III:III) = '0'
              ENDIF
  140       CONTINUE
            NFILE(8:10) = NFN(II)(8:10)
C
C           NOW READ IN THE CURRENT DATA
C
            ICUT = 0
            IF(IWROLD(II,I) .NE. 0) THEN
              OPEN(15,FILE=NFILE,STATUS='OLD',FORM='UNFORMATTED',
     +          ACCESS='SEQUENTIAL')
              REWIND 15
  150         CONTINUE
              READ(15,END=160) ICTOFF(ICUT+1),ICTNUM(ICUT+1)
              ICUT = ICUT + 1
              GO TO 150
  160         CONTINUE
            ELSE
              OPEN(15,FILE=NFILE,STATUS='NEW',FORM='UNFORMATTED',
     +          ACCESS='SEQUENTIAL')
            ENDIF
            REWIND 15
            DO 170 III = 1, ISVCNT
              IF(ISAVE(2,III) .EQ. I .AND. ISAVE(1,III) .EQ. II) THEN
                IF(ICUT .EQ. 0) THEN
                  ICUT = ICUT + 1
                  ICTOFF(ICUT) = ISAVE(3,III)
                  ICTNUM(ICUT) = 1
                ELSE
                  LFOUND = .FALSE.
                  DO 180 I4 = 1, ICUT
                    IF(.NOT. LFOUND) THEN
                      IF(ISAVE(3,III) .EQ. ICTOFF(I4)) THEN
                        LFOUND = .TRUE.
                        ICTNUM(I4) = ICTNUM(I4) + 1
                      ENDIF
                    ENDIF
  180             CONTINUE
                  IF(.NOT. LFOUND) THEN
                    ICUT = ICUT + 1
```

```
                ICTOFF(ICUT) = ISAVE(I,III)
                ICTNUM(ICUT) = 1
              ENDIF
            ENDIF
          ENDIF
 170      CONTINUE
C
C         NOW WRITE OUT NEW CUTPOINTS AND COUNTS
C
          DO 190 III = 1, ICUT
            WRITE(15) ICTOFF(III),ICTNUM(III)
 190      CONTINUE
          CLOSE(15)
C
C         UPDATE THE WRITE COUNTER
C
          IWROLD(II,I) = IWROLD(II,I) + IWRT(II,I)
        ENDIF
 130  CONTINUE
      WRITE(*,601) I,(IWRT(II,I),II=1,3),(IWROLD(II,I),II=1,3)
 601  FORMAT(1X,I5,3I8,3I13)
 100 CONTINUE
     ISVCNT = 0
 999 CONTINUE
     RETURN
     END
```

DISTRIBUTION FITTING PROGRAM SOURCE CODE

```
      PROGRAM AUTGF
C
C     THIS PROGRAM WILL FIT 4 CONTINUOUS AND 3 DISCRETE THEORETICAL
C     PROBABILITY DISTRIBUTIONS TO EMPIRICAL DEMAND DISTRIBUTIONS
C     AND DO GOODNESS-OF-FIT TESTING
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J). BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D). LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10).IVALS
      COMMON/DATA2/XCTOFF(5000),XPDF(5000).XCDF(5000).ICTOFF
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4).XLEVEL.
     +  XPARAM.ICELLS.LFAIL
      COMMON/NAMES/NDIST
      COMMON/GROUP/IGROUP(11).IGRP.ILVL(11)
      DIMENSION XPROBS(7)
      CHARACTER *35 NAMES(11),NSTAT(3),NERROR(10)
      CHARACTER *80 NTTL
      CHARACTER *24 NFN(3)
      DATA NAMES/'DEMAND FREQUENCY','ITEM CATEGORY',
     +  'MAX RQN SIZE','AVG RQN SIZE'.'DEMAND STABILITY',
     +  'AVG PRIORITY','AVG FMS CODE'.'ITEM PRICE',
     +  'ANNUAL DEMAND QUANTITY','FSC CODE'.'ANNUAL DEMAND VALUE'/
      DATA NSTAT/'DAIL/ DEMAND DATA','REQUISITION SIZE DATA'.
     +   'INTERARRIVAL DATA'/
      DATA NFN/'GRP000.DDD','GRP000.SIZ', 'GRP000.ARR'/
      CHARACTER *20 NDIST
      XLEVEL = 0.05
C
C     INPUT FILES:
C
C       UNIT 1: 'GRPDEF.SIM' - CONTAINS GROUPING DEFINITIONS
C
      WRITE(*,697)
  697 FORMAT(' 1FITTING DISTRIBUTIONS TO SIMULATION GROUPING ',
     +  'DATA FILES:')
C
C     READ THE GROUPING DEFINITIONS FOR THIS RUN
C
      OPEN(1,FILE='GRPDEF.SIM',STATUS='OLD')
      REWIND 1
C
C      NTTL  IS THE TITLE FOR THIS RUN
C
      READ(1,501) NTTL
  501 FORMAT(1X,A80)
      WRITE(*,698) NTTL
  698 FORMAT(' 0RUN TITLE = ',A80)
C
```

```
C     READ THE FIRST DATE FOR DATA COLLECTION
C
      READ(1,531) IFIRST
  531 FORMAT(I5)
C
C     CONVERT TO CONSECUTIVE DATE SINCE 78001
C
      I = IFIRST - 78000
      IYEAR = IYR/1000
      IDAY = I - (IYEAR * 1000)
      IFRSTD = (IYEAR * 365) + IDAY
C
C     ADJUST FOR LEAP YEAR IN 1980 IF PAST FEB28
C
      IF(IFRSTD .GT. 789) THEN
        IFRSTD = IFRSTD + 1
      ENDIF
      WRITE(*,696) IFRSTD, IFIRST
  696 FORMAT('0FIRST DATE FOR DATA COLLECTION = ',I5,
     +  '   JULIAN EQUIVALENT = ',I5)
C
C     READ ITEM SAMPLE AND DISTRIBUTION FITTING SAMPLE MAXES
C
C     READ THE NUMBER OF GROUPS 'IGRP'
C
      READ(1,502) IGRP
  502 FORMAT(I4)
C
C     FOR EACH GROUP, READ THE CORRESPONDING GROUPING VARIABLE
C     AND THE NUMBER OF LEVELS
C
      DO 125 I = 1, IGRP
        READ(1,503) IGROUP(I),ILVL(I)
  503   FORMAT(2I4)
C
C       FOR EACH LEVEL, READ THE CUTOFF VALUE
C
        DO 126 II = 1, ILVL(I)
          READ(1,504) X
  504     FORMAT(F12.4)
  126   CONTINUE
  125 CONTINUE
      CLOSE(1)
C
C     FIGURE TOTAL POSSIBLE GROUPINGS
C
      ITGRP = 1
      DO 130 I = 1, IGRP
        ITGRP = ITGRP * ILVL(I)
```

```
 130 CONTINUE
     WRITE(*,695) ITGRP
 695 FORMAT('0TOTAL GROUPINGS IN THIS RUN = ',I4)
     OPEN(14,FILE='GRPCDF.SIM',STATUS='OLD',FORM='UNFORMATTED',
    +  ACCESS='SEQUENTIAL',READONLY)
     REWIND 14
     OPEN(15,FILE='AVGSIZ.DAT',STATUS='NEW',FORM='UNFORMATTED',
    +  ACCESS='SEQUENTIAL')
     DO 190 I = 1, ITGRP
       READ(14) (XPROBS(II),II=1,7)
       WRITE(*,1616) I,XPROBS(7)
1616   FORMAT('0PROBABILITY OF POSITIVE DAILY DEMAND FOR GROUP ',
    +    I4,' = ',F10.7,/)
       WRITE(NFN(1),511) I
 511   FORMAT('GR',I4,'.DDD')
       DO 191 II = 3, 6
         IF(NFN(1)(II:II) .EQ. ' ') NFN(1)(II:II) = '0'
 191   CONTINUE
       NFN(2)(3:6) = NFN(1)(3:6)
       NFN(3)(3:6) = NFN(1)(3:6)
       IF(XPROBS(7) .GE. 0.12) THEN
         ISTRT = 1
         IEND = 1
       ELSE
         ISTRT = 2
         IEND = 3
       ENDIF
       DO 200 II = 1, 3
         WRITE(*,691) NSTAT(II),I
 691     FORMAT('0DATA SET = ',A35,' (GROUP ',I4,')')
         CALL RDDAT2(NFN(II))
         IF(ICTOFF .EQ. 0) THEN
           IF(II .EQ. 2) THEN
             XSTAT(4) = 0.0
             WRITE(15) XSTAT(4)
           ENDIF
           GO TO 200
         ENDIF
         CALL SSTATS
         IF(II .EQ. 2) THEN
           WRITE(15) XSTAT(4)
         ENDIF
         IF(II .LT. ISTRT .OR. II .GT. IEND) GO TO 200
         IF(XSTAT(7) .LT. 20.0) THEN
           PRINT *,'TOO FEW OBSERVATIONS TO PERFORM GOODNESS-',
    +        'OF-FIT TESTS'
           GO TO 200
         ENDIF
         CALL CNVRT2(1)
```

```
          CALL FITEXP
          CALL FITGAM
          IF(I .EQ. 1 .AND. II .EQ. 3) GO TO 203
          CALL FITWEI
  203     CONTINUE
          CALL FITUNI
          CALL CNVRT2(2)
          CALL CONVRT(1)
          CALL FITGEO
          CALL FITPOI
          CALL CONVRT(2)
          CALL FITDUN
  200   CONTINUE
  190 CONTINUE
      CLOSE(14)
      CLOSE(15)
  999 CONTINUE
      STOP
      END
      SUBROUTINE RDDAT2(NFILE)
C
C     READ IN USER DATA FROM FILE OR TERMINAL
C
      COMMON/DATA/XSTAT(10).IVALS
      COMMON/DATA2/XCTOFF(5000),XPDF(5000).XCDF(5000).ICTOFF
      CHARACTER *24 NFILE
      ICTOFF = 0
      INQUIRE(FILE=NFILE.EXIST=LEXIST)
      IF(.NOT. LEXIST) THEN
        RETURN
      ENDIF
      OPEN(1,FILE=NFILE.STATUS='OLD'.FORM='UNFORMATTED'.
     +  ACCESS='SEQUENTIAL')
      REWIND 1
      XTOT = 0.0
  200 CONTINUE
      READ(1.END=300) ICUT.INUM
      XCTOFF(ICTOFF+1) = FLOAT(ICUT)
      XPDF(ICTOFF+1) = FLOAT(INUM)
      ICTOFF = ICTOFF + 1
      XTOT = XTOT + XPDF(ICTOFF)
      GO TO 200
  300 CONTINUE
      IF(ICTOFF .GT. 1) THEN
        DO 210 I = 1. ICTOFF - 1
          DO 220 II = I + 1. ICTOFF
            IF(XCTOFF(I) .GT. XCTOFF(II)) THEN
              XSAVE = XCTOFF(I)
              XCTOFF(I) = XCTOFF(II)
```

```
                XCTOFF(II) = XSAVE
                XSAVE = XPDF(I)
                XPDF(I) = XPDF(II)
                XPDF(II) = XSAVE
              ENDIF
  220       CONTINUE
  210     CONTINUE
        ENDIF
        X = 0.0
        DO 400 I = 1, ICTOFF
          X = X + XPDF(I)
          XCDF(I) = X/XTOT
  400   CONTINUE
        CLOSE(1)
        RETURN
        END
        SUBROUTINE SSTATS
C
C       CALL SSTAT2 TO COMPUTE SIMPLE STATISTICS ON THE DATA AND
C       PRINT THE RESULTS
C
        COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
        COMMON/DATA/XSTAT(10),IVALS
        CALL SSTAT2
        WRITE(*,601) IVALS,(XSTAT(J),J=1,6)
  601   FORMAT('     OBS            MIN            MAX',
     +  '          TOTAL                MEAN          VARIANCE',
     +  '                  STD',/,
     +   1X,I6,3F12.1,3F16.4)
        RETURN
        END
        SUBROUTINE SSTAT2
C
C       COMPUTE SIMPLE STATISTICS ON THE DATA AND
C       SAVE INTO XSTAT(1 - 7):
C         XSTAT(1) - MIN
C         XSTAT(2) - MAX
C         XSTAT(3) - TOTAL
C         XSTAT(4) - MEAN
C         XSTAT(5) - VARIANCE
C         XSTAT(6) - STD.
C         XSTAT(7) - NUMBER OF OBSERVATIONS
C
        COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
        COMMON/DATA/XSTAT(10),IVALS
        XSTAT(1) = 100000.0
        XSTAT(2) = -1000000.0
        XSTAT(3) = 0.0
        XSTAT(7) = 0.0
```

```
      DO 100 I = 1, ICTOFF
        XSTAT(7) = XSTAT(7) + XPDF(I)
        XSTAT(3) = XSTAT(3) + (XCTOFF(I) * XPDF(I))
        IF(XCTOFF(I) .LT. XSTAT(1)) THEN
          XSTAT(1) = XCTOFF(I)
        ENDIF
        IF(XCTOFF(I) .GT. XSTAT(2)) THEN
          XSTAT(2) = XCTOFF(I)
        ENDIF
  100 CONTINUE
      XSTAT(4) = XSTAT(3)/XSTAT(7)
      IVALS = INT(XSTAT(7))
      XVAR = 0.0
      DO 110 I = 1, ICTOFF
        XVAR = XVAR + (((XSTAT(4) - XCTOFF(I))**2)
     +     * XPDF(I))
  110 CONTINUE
      IF(IVALS .GT. 1) THEN
        XSTAT(5) = XVAR/(XSTAT(7) - 1.0)
      ELSE
        XSTAT(5) = XVAR/XSTAT(7)
      ENDIF
      XSTAT(6) = SQRT(XSTAT(5))
      RETURN
      END
      SUBROUTINE CNVRTZ(IOPT)
C
C     CONVERT DATA SO THAT MINIMUM IS GREATER THAN ZERO
C
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
      IF(IOPT .EQ. 1) THEN
        XSAVE = XSTAT(1)
        IF(XSAVE .GT. 0.0) RETURN
        XADD = 1.0 - XSTAT(1)
        DO 10 I = 1, ICTOFF
          XCTOFF(I) = XCTOFF(I) - XADD
   10   CONTINUE
      ELSE
        IF(XSAVE .GT. 0.0) RETURN
        DO 20 I = 1, ICTOFF
          XCTOFF(I) = XCTOFF(I) - XADD
   20   CONTINUE
      ENDIF
      CALL SSTATZ
      IF(IOPT .EQ. 1) THEN
        PRINT *,' '
        PRINT *,'   CONVERTING DATA TO HAVE MINIMUM VALUE ',
     -       'GREATER THAN ZERO'
```

```
        PRINT *,'  FOR FITTING GAMMA AND WEIBULL DISTRIBUTIONS'
        PRINT *,'  CONVERSION VALUE ADDED = ',XADD
      ENDIF
      RETURN
      END
      SUBROUTINE CONVRT(IOPT)
C
C     CONVERT DATA SO THAT MINIMUM IS ZERO FOR FITTING A POISSON
C     AND A GEOMETRIC DISTRIBUTION
C
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
      IF(IOPT .EQ. 1) THEN
        XSAVE = XSTAT(1)
        IF(XSAVE .EQ. 0.0) RETURN
        DO 10 I = 1, ICTOFF
          XCTOFF(I) = XCTOFF(I) - XSAVE
   10   CONTINUE
      ELSE
        IF(XSAVE .EQ. 0.0) RETURN
        DO 20 I = 1, ICTOFF
          XCTOFF(I) = XCTOFF(I) + XSAVE
   20   CONTINUE
      ENDIF
      CALL SSTAT2
      IF(IOPT .EQ. 1) THEN
        PRINT *,' '
        PRINT *,'  CONVERTING DATA TO HAVE MINIMUM VALUE OF ZERO'
        PRINT *,'  FOR FITTING POISSON AND GEOMETRIC DISTRIBUTIONS'
        PRINT *,'  CONVERSION VALUE = ',XSAVE
      ENDIF
      RETURN
      END
      FUNCTION XFACT(X)
C
C     CALCULATE FACTORIAL OF INT(X)
C
      XFACT = 1.0
      ILAST = INT(X)
      IF(ILAST .LT. 2) RETURN
      DO 100 I = 2, ILAST
        XFACT = XFACT * FLOAT(I)
  100 CONTINUE
      RETURN
      END
      SUBROUTINE FITDUN
C
C     ESTIMATE PARAMETERS OF DISCRETE UNIFORM DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
```

```
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      EXTERNAL DUNPMF
      XPARAM = 2.0
      NDIST = 'DISCRETE UNIFORM'
      XPARM(1) = XSTAT(1)
      XPARM(2) = XSTAT(2)
      WRITE(*,600)
  600 FORMAT(/,' FITTING A DISCRETE UNIFORM DISTRIBUTION:')
      WRITE(*,601) XPARM(1),XPARM(2)
  601 FORMAT('    ESTIMATED MINIMUM = ',F12.0,/,
     +  '    ESTIMATED MAXIMUM = ',F12.0)
C
C     DO CHI-SQUARE TEST.
C
      IF(IVALS .LT. 50) THEN
        PRINT *,'**ERROR - LESS THAN 50 OBSERVATIONS. CHI- .
     +      SQUARE TEST NOT VALID'
        IF(IVALS .LT. 20) THEN
          GO TO 999
        ENDIF
      ENDIF
C
C     DO THE CHI-SQUARE TEST FOR DISCRETE DISTRIBUTION
C
      CALL CHDISC(DUNPMF)
  999 CONTINUE
      RETURN
      END
      SUBROUTINE DUNPMF(X,XPMF)
C
C     COMPUTE THE PROBABILITY MASS FUNCTION FOR A DISCRETE DIST.
C
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      XRANGE = (XPARM(2) - XPARM(1)) + 1.0
      XPMF = 1.0/XRANGE
      RETURN
      END
      SUBROUTINE FITEXP
```

```
C
C     ESTIMATE PARAMETERS OF EXPONENTIAL DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL.
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      EXTERNAL EXPCDF
      NDIST = 'EXPONENTIAL'
      LFAIL = .TRUE.
      XPARAM = 1.0
      XPARM(1) = 1.0/XSTAT(4)
      WRITE(*,600)
  600 FORMAT(/,' FITTING AN EXPONENTIAL DISTRIBUTION:')
      WRITE(*,601) XPARM(1)
  601 FORMAT('   ESTIMATED PARAMETER = ',F12.4)
C
C     DO CHI-SQUARE TEST HERE
C
      CALL CHCONT(EXPCDF)
      RETURN
      END
      SUBROUTINE EXPCDF(X.XPROB)
C
C     COMPUTE THE CDF - F(X) FOR THE EXPONENTIAL DISTRIBUTION
C
      COMMON/TEST/XCELL(5000).XCHI(5000),XPARM(4),XLEVEL.
     +  XPARAM,ICELLS,LFAIL
      XPROB = 0.0
      IF(X .LT. 0.0) RETURN
      XPROB = 1.0 - EXP(-1.0 * XPARM(1) * X)
      RETURN
      END
      SUBROUTINE FITGAM
C
C     ESTIMATE PARAMETERS OF GAMMA DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
C
C       LFAIL - LOGICAL RESULT (.TRUE. = FAILURE)
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
```

```
      COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL.
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      DIMENSION XMTBL(101),XBTBL(101)
      EXTERNAL GAMCDF
      DATA XMTBL/0.02,0.03,0.04,0.05,0.06,0.07,0.08,0.09,
     +  0.1,0.2.0.3,0.4, 0.5,0.6,0.7,0.8,0.9,
     +  1.0,1.1,1.2.1.3,1.4,1.5,1.6,1.7,1.8,1.9,
     +  2.0,2.1.2.2,2.3,2.4.2.5,2.6,2.7,2.8,2.9,3.0.3.2,3.4,
     +  3.6,3.8,4.0,4.2,4.4,4.6,4.8,5.0,5.2,5.4,5.6.5.8,6.0,
     +  6.2.6.4.6.6.6.8,7.0.7.3,7.6,7.9.8.2,8.5.8.8.9.1.9.4.
     +  9.7.10.0.10.3,10.6.10.9.11.2.11.5.11.8,12.1.12.4.12.7.
     +  13.0.13.3.13.6,13.9.14.2,14.5,14.8,15.1,15.4.15.7.16.0.
     +  16.3.16.6.16.9.17.2,17.5,17.8,18.1.18.4,18.7,19.0.19.3.
     +  19.6,20.0/
      DATA XBTBL/0.0187,0.0275,0.0360,0.0442,0.0523.0.0602,
     +  0.0679,0.0756,0.0831,0.1532,0.2178,0.2790,0.3381.
     +  0.3955,0.4517.0.5070,0.5615,0.6155,0.6690,0.7220,
     +  0.7748,0.8272,0.8794,0.9314,0.9832,1.034,1.086,
     +  1.137,1.188,1.240,1.291,1.342.1.393,1.444,1.494,
     +  1.545.1.596,1.646,1.748,1.849,1.950.2.051,2.151.
     -  2.252.2.353,2.453,2.554,2.654,2.755.2.855.2.956.
     +  3.056.3.156,3.257.3.357.3.457.3.558,3.658.3.808.
     +  3.958.4.109,4.259,4.409.4.560.4.710.4.860.5.010.
     +  5.160,5.311,5.461,5.611.5.761.5.911,6.061,6.211.
     +  6.362,6.512.6.662,6.812.6.962.7.112.7.262.7,412.
     +  7.562.7.712.7.862.8.013.8.163.8.313.8.463.8.613.
     +  8.763.8.913.9.063,9.213.9.363,9.513.9.663.9.813.
     +  9.963.10.16/
      XPARAM = 2.0
      NDIST = 'GAMMA'
      XLOG = 0.0
      DO 5 I = 1. ICTOFF
        XLOG = XLOG - (ALOG(XCTOFF(I)) * XPDF(I))
    5 CONTINUE
      XM = ALOG(XSTAT(4)) - ((1.0/XSTAT(7)) + XLOG
C
C     USE LOOK-UP PROCEDURE TO FIND BETA
C
      XLOOK = 1.0/XM
      IF(XLOOK .EQ. XMTBL(1)) THEN
        XPARM(1) = XBTBL(1)
      ELSEIF(XLOOK .LT. XMTBL(1) .OR. XLOOK .GT. XMTBL(101))
     +  THEN
C
C       COMPUTE ALTERNATE PARAMETER ESTIMATES
C
```

```
        XADJ = (XSTAT(7) - 1.0)/XSTAT(7)
        XS2NEW = XSTAT(5) * XADJ
        XSNEW = SQRT(XSTAT(5))
        XPARM(1) = XS2NEW/XSTAT(4)
        XPARM(2) = (XSTAT(4)/XSNEW)**2
        PRINT *,'**WARNING - LOOK-UP VALUE EXCEEDS TABLE ',
     +    'LIMITS, NON-MLE PARAMETERS WERE ESTIMATED:'
        PRINT *,'**LOOK-UP VALUE = ',XLOOK
        GO TO 200
      ELSEIF(XLOOK .EQ. XMTBL(101)) THEN
        XPARM(1) = XBTBL(101)
      ELSE
        DO 6 I = 1, 100
          IF(XLOOK .GT. XMTBL(I) .AND. XLOOK .LE.
     +        XMTBL(I+1)) THEN
            XRNG1 = XMTBL(I+1) - XMTBL(I)
            XRNG2 = XBTBL(I+1) - XBTBL(I)
            XDIF = XLOOK - XMTBL(I)
            XPCNT = XDIF/XRNG1
            XPARM(1) = XBTBL(I) + (XPCNT * XRNG2)
          ENDIF
    6   CONTINUE
      ENDIF
      XPARM(2) = XSTAT(4)/XPARM(1)
  200 CONTINUE
      WRITE(*,600)
  600 FORMAT(/,' FITTING A GAMMA DISTRIBUTION: ')
      WRITE(*,601) XPARM(2),XPARM(1)
  601 FORMAT(' ESTIMATED SCALE PARAMETER = ',F12.4,/,
     +  ' ESTIMATED SHAPE PARAMETER = ',F12.4)
C
C     DO CHI-SQUARE TEST HERE
C
      CALL CHCONT(GAMCDF)
  999 CONTINUE
      RETURN
      END
      SUBROUTINE GAMCDF(X,XPROB)
C
C     COMPUTE THE CDF - F(X) FOR THE GAMMA DISTRIBUTION
C
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      XPROB = 0.0
C
C     DIVIDE INPUT X VALUE BY THE ESTIMATED SCALE PARAMETER
C
      IF(X .LT. 0.0) RETURN
      XNEW = X/XPARM(2)
```

```
      CALL MDGAM(XNEW,XPARM(1),XPROB,IER)
      IF(IER .EQ. 129) THEN
        PRINT *,'**TERMINAL ERROR IN IMSL ROUTINE MDGAM, ',
     +     'X IS LESS THAN ZERO'
      ELSEIF(IER .EQ. 130) THEN
        PRINT *,'**TERMINAL ERROR IN IMSL ROUTINE MDGAM, ',
     +     'P IS LESS THAN OR EQUAL TO ZERO'
      ENDIF
      RETURN
      END
      SUBROUTINE FITGEO
C
C     ESTIMATE PARAMETERS OF POISSON DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      EXTERNAL GEOPMF
      XPARAM = 1.0
      NDIST = 'GEOMETRIC'
      XPARM(1) = 1.0/(XSTAT(4) + 1.0)
      WRITE(*,600)
  600 FORMAT(/,' FITTING A GEOMETRIC DISTRIBUTION:')
      WRITE(*,601) XPARM(1)
  601 FORMAT('    ESTIMATED PARAMETER (P) = ',F12.4)
C
C     DO CHI-SQUARE TEST.
C
      IF(IVALS .LT. 50) THEN
        PRINT *,'**ERROR - LESS THAN 50 OBSERVATIONS, CHI-',
     -     'SQUARE TEST NOT VALID'
        IF(IVALS .LT. 20) THEN
          GO TO 999
        ENDIF
      ENDIF
C
C     DO THE CHI-SQUARE TEST FOR DISCRETE DISTRIBUTION
C
      CALL CHDISC(GEOPMF)
  999 CONTINUE
      RETURN
      END
      SUBROUTINE GEOPMF(X,XPMF)
```

```
C
C     COMPUTE THE GEOMETRIC PROBABILITY MASS FUNCTION FOR A GIVEN
C     PARAMTER AND VALUE
C
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      XPMF = XPARM(1) * ((1.0 - XPARM(1))**X)
      RETURN
      END
      SUBROUTINE FITNOR
C
C     ESTIMATE PARAMETERS OF NORMAL DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      EXTERNAL XNMCDF
      XPARAM = 2.0
      NDIST = 'NORMAL'
      XPARM(1) = XSTAT(4)
      XPARM(2) = XSTAT(5)
      WRITE(*,600)
  600 FORMAT(/,' FITTING A NORMAL DISTRIBUTION:')
      WRITE(*,601) XPARM(1),XPARM(2)
  601 FORMAT(' ESTIMATED MEAN = ',F12.4,/,
     +  '     ESTIMATED VARIANCE = ',F15.5)
C
C     DO CHI-SQUARE TEST HERE
C
      CALL CHCONT(XNMCDF)
      RETURN
      END
      SUBROUTINE XNMCDF(X,XPROB)
C
C     COMPUTE THE CDF - F(X) FOR THE NORMAL DISTRIBUTION
C
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      COMMON/DATA/XSTAT(10),IVALS
      XPROB = 0.0
C
C     DIVIDE INPUT X VALUE BY THE ESTIMATED SCALE PARAMETER
C
```

```
      XNEW = (X - XPARM(1))/XSTAT(6)
      CALL MDNOR(XNEW,XPROB)
      RETURN
      END
      SUBROUTINE FITPOI
C
C     ESTIMATE PARAMETERS OF POISSON DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
C
      IMPLICIT INTEGER *4 (I.K.M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10).IVALS
      COMMON/TEST/XCELL(5000).XCHI(5000),XPARM(4).XLEVEL,
     +  XPARAM.ICELLS.LFAIL
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      EXTERNAL POIPMF
      XPARAM = 1.0
      IF(XSTAT(2) .GT. 33.0) THEN
        PRINT *,' '
        PRINT *,'CANNOT DO POISSON FIT'
        GO TO 999
      ENDIF
      NDIST = 'POISSON'
      XPARM(1) = XSTAT(4)
      WRITE(*,600)
  600 FORMAT(/,' FITTING A POISSON DISTRIBUTION:')
      WRITE(*,601) XPARM(1)
  601 FORMAT('   ESTIMATED PARAMETER = ',F12.4)
C
C     DO CHI-SQUARE TEST.
C
      IF(IVALS .LT. 50) THEN
        PRINT *,'**ERROR - LESS THAN 50 OBSERVATIONS, CHI- ',
     -      'SQUARE TEST NOT VALID'
        IF(IVALS .LT. 20) THEN
          GO TO 999
        ENDIF
      ENDIF
      CALL CHDISC(POIPMF)
  999 CONTINUE
      RETURN
      END
      SUBROUTINE POIPMF(X,XPMF)
C
C     COMPUTE THE POISSON PROBABILITY MASS FUNCTION FOR A GIVEN
C     PARAMETER AND VALUE
C
```

```
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      XPMF = (EXP(-1.0 * XPARM(1)) * (XPARM(1)**
     +  X))/XFACT(X)
      RETURN
      END
      SUBROUTINE FITUNI
C
C     ESTIMATE PARAMETERS OF UNIFORM DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      EXTERNAL UNICDF
      XPARAM = 2.0
      NDIST = 'UNIFORM'
      XPARM(1) = XSTAT(1)
      XPARM(2) = XSTAT(2)
      WRITE(*,600)
  600 FORMAT(/,' FITTING A UNIFORM DISTRIBUTION:')
      WRITE(*,601) XPARM(1),XPARM(2)
  601 FORMAT('      ESTIMATED LOWER LIMIT = ',F12.4,/,
     +  '      ESTIMATED UPPER LIMIT = ',F12.4)
C
C     DO CHI-SQUARE TEST HERE
C
      CALL CHCONT(UNICDF)
      RETURN
      END
      SUBROUTINE UNICDF(X,XPROB)
C
C     COMPUTE THE CDF - F(X) FOR THE UNIFORM DISTRIBUTION
C
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      XPROB = 0.0
      IF(X .LT. XPARM(1)) THEN
        RETURN
      ELSEIF(X .GT. XPARM(2)) THEN
        XPROB = 1.0
        RETURN
      ENDIF
      XPROB = (X - XPARM(1) + 1.0)/(XPARM(2) - XPARM(1) + 1.0)
```

```
      RETURN
      END
      SUBROUTINE FITWEI
C
C     ESTIMATE PARAMETERS OF WEIBULL DISTRIBUTION AND
C     PERFORM GOODNESS-OF-FIT TEST
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (X-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     + XPARAM,ICELLS,LFAIL
      COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
      COMMON/NAMES/NDIST
      CHARACTER *20 NDIST
      EXTERNAL WEICDF
      XPARAM = 2.0
      NDIST = 'WEIBULL'
C
C     ESTIMATE THE PARAMATERS USING ITERATIVE PROCEDURE
C     DESCRIBED IN "DISCRETE-EVENT SYSTEM SIMULATION", BY
C     BANKS AND CARSON, PRENTICE-HALL, 1984.
C
C     (A TOTAL OF 3 TRIES WILL BE ATTEMPTED. XERROR = 0.001 IS
C       THE CONVERGENCE MEASURE)
C
C       1) INITIAL ESTIMATE OF BETA = MEAN/STD
C       2) 0.5 * INITIAL ESTIMATE
C       3) 2 * INITIAL ESTIMATE
C
      ITRY = 0
      XINIT = XSTAT(4)/XSTAT(6)
      XERROR = 0.001
  100 CONTINUE
      ITRY = ITRY + 1
      IF (ITRY .EQ. 1) THEN
        XBOLD = XINIT
      ELSEIF (ITRY .EQ. 2) THEN
        XBOLD = XINIT/2.0
      ELSEIF (ITRY .EQ. 3) THEN
        XBOLD = XINIT * 2.0
      ELSE
C
C       WEIBULL FIT HAS FAILED IN PARAMETER ESTIMATION STAGE
C
        WRITE(*,599)
  599   FORMAT(/,' **WEIBULL PARAMETER ESTIMATION ALGORITHM ',
     +        'FAILED TO CONVERGE')
```

```
          GO TO 999
        ENDIF
C
C       SET ITER = 0 AND DO NEWTONS METHOD A MAXIMUM OF NINE
C         TIMES BEFORE TRYING ANOTHER INITIAL ESTIMATE
C
        ITER = 0
  110   CONTINUE
        ITER = ITER + 1
C
C       CALCULATE 4 TERMS
C
C       1) XTERM1 = SUM(LOG(X))
C       2) XTERM2 = SUM(X**XBOLD)
C       3) XTERM3 = SUM((X**B) * (LOG(X)))
C       4) XTERM4 = SUM((X**B) * (LOG(X)**2))
C
        XTERM1 = 0.0
        XTERM2 = 0.0
        XTERM3 = 0.0
        XTERM4 = 0.0
        DO 120 I = 1, ICTOFF
          IEND = INT(XPDF(I))
          DO 130 II = 1, IEND
            XLOG = ALOG(XCTOFF(I))
            XB = XCTOFF(I)**XBOLD
            XTERM1 = XTERM1 + XLOG
            XTERM2 = XTERM2 + XB
            XTERM3 = XTERM3 + (XB * XLOG)
            XTERM4 = XTERM4 + (XB * (XLOG**2))
  130     CONTINUE
  120   CONTINUE
        XN = XSTAT(7)
        XFB = (XN/XBOLD) - XTERM1 - ((XN * XTERM3)/XTERM2)
        XFBPRM = ((-1. * XN)/(XBOLD**2)) -
     +   ((XN * XTERM4)/XTERM2) +
     +   ((XN * (XTERM3**2))/(XTERM2**2))
        XBNEW = XBOLD - (XFB/XFBPRM)
        IF(ABS(XFB) .GT. XERROR) THEN
          IF(ITER .LT. 9) THEN
            XBOLD = XBNEW
            GO TO 110
          ELSE
            GO TO 100
          ENDIF
        ELSE
C
C         THE PROCEDURE HAS CONVERGED SO CALCULATE ALPHA
C
```

```
        XTERM2 = 0.0
        DO 131 I = 1, ICTOFF
          XTERM2 = XTERM2 + ((XCTOFF(I)**XBNEW)
     +       * XPDF(I))
 131    CONTINUE
        XALPHA = ((1.0/XN) * XTERM2)**(1.0/XBNEW)
        XBETA = XBNEW
        XPARM(2) = XALPHA
        XPARM(1) = XBETA
      ENDIF
      WRITE(*,600)
 600  FORMAT(/,' FITTING A WEIBULL DISTRIBUTION:')
      WRITE(*,601) XPARM(2),XPARM(1)
 601  FORMAT('    ESTIMATED SCALE PARAMETER = ',F12.4,/,
     +  '    ESTIMATED SHAPE PARAMETER = ',F12.4,/,
     +  '    ASSUMING A LOCATION PARAMETER OF 0.0',/)
      CALL CHCONT(WEICDF)
 999  CONTINUE
      RETURN
      END
      SUBROUTINE WEICDF(X,XPROB)
C
C     COMPUTE THE CDF - F(X) FOR THE WEIBULL DISTRIBUTION
C
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      XPROB = 0.0
      IF(X .LT. 0.0) RETURN
      XPROB = 1.0 - EXP(-1.0 + (X/XPARM(2))**XPARM(1))
      RETURN
      END
      SUBROUTINE CHCONT(CDF)
C
C     TEST GOODNESS-OF-FIT OF THE HYPOTHESIZED CONTINUOUS
C     DISTRIBUTION
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      DIMENSION XHPDF(5000),XHCDF(5000)
      DIMENSION XDIFF(5000)
      DIMENSION XEXPCT(5000)
      CHARACTER *20 NDIST
      CHARACTER *20 NFIRST, NLAST
```

```
      EXTERNAL CDF
      XTOT = 0.0
      DO 100 I = 1, ICTOFF
        CALL CDF(XCTOFF(I),XHCDF(I))
        IF(I .EQ. 1) THEN
          XHPDF(I) = XHCDF(I)
        ELSE
          XHPDF(I) = XHCDF(I) - XHCDF(I-1)
        ENDIF
        XEXPCT(I) = XHPDF(I) * XSTAT(7)
        IF(XEXPCT(I) .GT. 0.0) THEN
          XDIFF(I) = ((XPDF(I) - XEXPCT(I))**2)/XEXPCT(I)
        ELSE
          XDIFF(I) = XPDF(I)
        ENDIF
        XTOT = XTOT + XDIFF(I)
100   CONTINUE
      WRITE(*,601)
601   FORMAT('    GOODNESS-OF-FIT TEST:')
      WRITE(*,605) XTOT
605   FORMAT('    TEST VALUE = ',F16.4)
      WRITE(*,626)
626   FORMAT('    DEVIATIONS:')
      WRITE(*,616)
616   FORMAT('    CELL      DEVIATION      FROM          TO',
     +               OBS     EXPECT         PDF       HPDF         CDF        HCDF')
      X0 = 0.0
      IF(ICTOFF .GT. 10) THEN
        IMIN = 5
        IMAX = ICTOFF - 4
      ELSE
        IMIN = ICTOFF
        IMAX = 1
      ENDIF
      DO 200 I = 1, ICTOFF
        IF(I .LE. IMIN .OR. I .GE. IMAX) THEN
          X1 = XPDF(I)/XSTAT(7)
          IF(I .EQ. 1) THEN
            WRITE(*,607) I,XDIFF(I),X0,XCTOFF(I),
     +        XPDF(I),XEXPCT(I),X1,XHPDF(I),
     +        XCDF(I),XHCDF(I)
607         FORMAT(1X,I6,F14.1,2F9.0,2F10.0,4F10.7)
          ELSE
            WRITE(*,607) I,XDIFF(I),XCTOFF(I-1),
     +        XCTOFF(I),XPDF(I),XEXPCT(I),
     +        X1,XHPDF(I),
     +        XCDF(I),XHCDF(I)
          ENDIF
        ENDIF
```

```
  133 CONTINUE
      WRITE(*,608) XHCDF(ICTOFF)
  608 FORMAT('   HYPOTHESIZED CDF AT MAXIMUM OBSERVED ',
     +  'VALUE = ',F8.6)
      RETURN
      END
      SUBROUTINE CHDISC(PMF)
C
C     TEST GOODNESS-OF-FIT OF THE HYPOTHESIZED DISCRETE
C     DISTRIBUTION
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B)
      IMPLICIT REAL (O-Z), DOUBLE PRECISION (D), LOGICAL (L)
      IMPLICIT CHARACTER (N)
      COMMON/DATA/XSTAT(10),IVALS
      COMMON/DATA2/XCTOFF(5000),XPDF(5000),XCDF(5000),ICTOFF
      COMMON/TEST/XCELL(5000),XCHI(5000),XPARM(4),XLEVEL,
     +  XPARAM,ICELLS,LFAIL
      COMMON/NAMES/NDIST
      DIMENSION XEXPCT(5000),XOBSVD(5000)
      DIMENSION XVALUE(5000),XHPDF(5000),XHCDF(5000)
      CHARACTER *20 NDIST
      EXTERNAL PMF
  100 CONTINUE
C
C     FIGURE EXPECTED PROBABILITY AND FREQUENCY
C
      DO 10 I = 1, ICTOFF
        XOBSVD(I) = XPDF(I)
        XVALUE(I) = XCTOFF(I)
        IF(I .EQ. 1) THEN
          CALL PMF (XCTOFF(I),XHCDF(I))
          XHPDF(I) = XHCDF(I)
        ELSE
          ISTRT = INT(XCTOFF(I-1)) + 1
          IEND = INT(XCTOFF(I))
          XHPDF(I) = 0.0
          DO 20 II = ISTRT, IEND
            X1 = FLOAT(II)
            CALL PMF(X1,X2)
            XHPDF(I) = XHPDF(I) + X2
   20     CONTINUE
          XHCDF(I) = XHCDF(I-1) + XHPDF(I)
        ENDIF
        XEXPCT(I) = XHPDF(I) * XSTAT(7)
   10 CONTINUE
C
C     CONSTRAIN EACH CELL TO HAVE AT LEAST XLOW = 5.0
C
```

```
      XLOW = 5.0
      IFIRST = 1
      ICELLS = ICTOFF
   30 CONTINUE
      IF(XEXPCT(IFIRST) .LT. XLOW) THEN
        IF(IFIRST .LT. ICELLS) THEN
          XEXPCT(IFIRST + 1) = XEXPCT(IFIRST + 1) + XEXPCT(IFIRST)
          XOBSVD(IFIRST + 1) = XOBSVD(IFIRST + 1) + XOBSVD(IFIRST)
          IFIRST = IFIRST + 1
        ELSE
          PRINT *,'**ERROR - TOO FEW CELLS FOR CHI-SQUARE TEST'
          RETURN
        ENDIF
        GO TO 30
      ENDIF
C
C     CHECK LAST CLASS TO BE SURE IT CONTAINS AT LEAST
C     5.0 EXPECTED VALUES
C
   40 CONTINUE
      IF(XEXPCT(ICELLS) .LT. XLOW) THEN
        IF(ICELLS .EQ. IFIRST) THEN
          PRINT *,'**ERROR - TOO FEW CELLS FOR CHI-SQUARE TEST'
          RETURN
        ENDIF
        ICELLS = ICELLS - 1
        XEXPCT(ICELLS) = XEXPCT(ICELLS) + XEXPCT(ICELLS + 1)
        XOBSVD(ICELLS) = XOBSVD(ICELLS) + XOBSVD(ICELLS + 1)
        XVALUE(ICELLS) = XVALUE(ICELLS + 1)
        GO TO 40
      ENDIF
C
C     COMPUTE CHI-SQUARE STATISTIC
C
      XCHISQ = 0.0
      DO 200 I = IFIRST, ICELLS
        IF(XEXPCT(I) .GT. 0.0) THEN
          X = ((XOBSVD(I) - XEXPCT(I))**2)/XEXPCT(I)
        ELSE
          X = XOBSVD(I)
        ENDIF
        XCHISQ = XCHISQ + X
  200 CONTINUE
      XPHI = 1.0 - XLEVEL
      ITOT = (ICELLS - IFIRST) + 1
      XDF = FLOAT(ITOT) - (XPARAM + 1.0)
      IF(XDF .LT. 1.0) THEN
        PRINT *,'**ERROR - TOO FEW CELLS FOR CHI-SQUARE TEST'
        RETURN
```

```
      ENDIF
      CALL MDCHI(XPHI,XDF,XCRIT,IER)
      CALL MDCH(XCHISQ,XDF,XP,IER)
      XPTAIL = 1.0 - XP
      WRITE(*,601)
  601 FORMAT('   CHI-SQUARE GOODNESS-OF-FIT TEST:')
      WRITE(*,602) NDIST,NDIST
  602 FORMAT('   H0: SAMPLE DATA DISTRIBUTED AS ',A20,/,
     +  '   H1: SAMPLE DATA NOT DISTRIBUTED AS ',A20)
      IF(ITOT .LE. 10) THEN
        IMIN = ICELLS
        IMAX = IFIRST
      ELSE
        IMIN = IFIRST + 4
        IMAX = ICELLS - 4
      ENDIF
      WRITE(*,603)
  603 FORMAT('   CLASS     VALUE  OBS FREQ       EXP FREQ       ',
     +  '  CHI VALUE')
      ICLASS = 0
      DO 300 I = IFIRST, ICELLS
        ICLASS = ICLASS + 1
        IF(XEXPCT(I) .GT. 0.0) THEN
          X = ((XOBSVD(I) - XEXPCT(I))**2)/XEXPCT(I)
        ELSE
          X = XOBSVD(I)
        ENDIF
        IF(I .LE. IMIN .OR. I .GE. IMAX) THEN
          WRITE(*,607) ICLASS,INT(XVALUE(I)),INT(XOBSVD(I)),
     +      XEXPCT(I),X
  607     FORMAT(1X,I7,2I10,F15.4,F17.2)
          XCHISQ = XCHISQ + X
        ENDIF
  300 CONTINUE
      WRITE(*,631) IVALS,XSTAT(7),XCHISQ
  631 FORMAT('    TOTAL',10X,I10,F15.4,F17.2)
      WRITE(*,604) XCHISQ,XLEVEL,XDF,XCRIT
  604 FORMAT('   TEST STATISTIC = ',F16.4,/,
     +  '      ALPHA LEVEL = ',F5.3,/,
     +  '      DEGRESS OF FREEDOM = ',F12.0,/,
     +  '   CRITICAL VALUE FOR TEST STATISTIC = ',F12.4)
      WRITE(*,613) XPTAIL
  613 FORMAT('   P-TAIL = ',F9.7)
      IF(XCHISQ .LE. XCRIT) THEN
        PRINT *,'  ***** TEST RESULT *****   CANNOT REJECT H0'
        LFAIL = .FALSE.
      ELSE
        PRINT *,'  ***** TEST RESULT *****   REJECT H0'
        LFAIL = .TRUE.
```

```
      ENDIF
      RETURN
      END
```

DEMAND SIMULATION PROGRAM SOURCE CODE

```
      PROGRAM SIMDMD
C
C     SIMULATE DEMAND AND MIGRATION FOR 40909 DESC INVENTORY ITEMS
C     ON A QUARTER BY QUARTER BASIS
C
C     POSSIBLE ITEM GROUPINGS CHARACTERISTICS ARE:
C
C      1) ANNUAL DEMAND FREQUENCY
C      2) ITEM CATEGORY (N-S, NSO, RL, RM, RH1, RH2)
C      3) MAXIMUM RQN SIZE (QUARTERLY)
C      4) AVG RQN SIZE (QUARTERLY)
C      5) DEMAND STABILITY (# OF CONSECUTIVE QUARTERS IN CURRENT
C         CATEGORY)
C      6) AVG PRIORITY (QUARTERLY)
C      7) AVG FMS CODE (QUARTERLY)
C      8) ITEM PRICE (AS OF FRAC ENTRY FOR JUL-SEP 81)
C      9) ANNUAL DEMAND QUANTITY (ADQ)
C     10) FSC CODE
C     11) ANNUAL DEMAND VALUE (PRICE * ADQ)
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), LOGICAL (L), CHARACTER (N)
      COMMON/GROUP/IGROUP(11),XLEVEL(100,11),IGRP,ILEVEL(11)
      COMMON/SIMDAT/XPRIOR(3,1000),XFMS(3,1000),XDP4RM(4,1000),
     +  XDAILY(1000),IDSTYP(2,1000),LDAILY(1000)
      COMMON/ITMDAT/JITEM(41000),XDAYS(41000),LITEM(41000),
     +  XPRICE(41000),BSTAB(2,41000),BFCODE(41000)
      COMMON/GRPDAT/IGCNT(1000),IGOLD(1000),IGOUT(1000),IGIN(1000),
     +  BLEVEL(11,1000)
      COMMON/MIGRAT/IACAT(7,7),ISCAT(7,7)
      COMMON/DEMAND/XACAT(4,7,14),XSCAT(4,7,14),XAFSC(4,31,14),
     +  XSFSC(4,31,14)
      COMMON/GRPDMD/XGNDMD(4,2,1000),XGNPRI(4,1000),XGNFMS(4,1000)
      COMMON/EMPIR/XCDF(2,20000),XCTOFF(2,20000),
     +  ICTOFF(2)
      COMMON/DMDFRQ/ISFREQ(5,14),IAFREQ(5,14),XAVSIZ(1000),XDMIN(2,1000)
      COMMON/NAMEMP/NEMPIR(2,1000)
      COMMON/SMOOTH/XSM(2,41000),XSDMD(5,41000),XSFRQ(5,41000),
     +  BSTYP(41000)
      COMMON/GRPSTI/XGPOS(1000),IGRPOB(3,1000)
      COMMON/MIGSAV/BMIG(15,41000),XBMIG(41000),BSTBIL(41000),
     +  ISTCNT(20),IJUMP(20)
      DIMENSION BDUMMY(10),XWORK(50),IWORK(50)
      DIMENSION XWORK2(50)
      DIMENSION JITEMO(41000)
      CHARACTER *25 NAMES(11)
      CHARACTER *80 NTTL
      CHARACTER *10 NEMPIR
      CHARACTER *25 NDNAME(11)
```

DEMAND SIMULATION PROGRAM SOURCE CODE

```
      CHARACTER *10 NAMCAT(7)
      CHARACTER *20 NAMCMP(4)
      CHARACTER *20 NAMRND(5)
      DATA NAMCMP/'DEMAND QUANTITY','DEMAND FREQUENCY',
     + 'DEMAND VALUE','DV (CONSTANT PRICE)'/
      DATA NDNAME/'EMPIRICAL','EXPONENTIAL','WEIBULL',
     + 'GAMMA','UNIFORM','NORMAL','ERLANG','TRIANGULAR',
     + 'GEOMETRIC','POISSON','DISCRETE-UNIFORM'/
      DATA NAMES/'DEMAND FREQUENCY','ITEM CATEGORY',
     + 'MAX RQN SIZE','AVG RQN SIZE','DEMAND STABILITY',
     + 'AVG PRIORITY','AVG FMS CODE','ITEM PRICE',
     + 'ANNUAL DEMAND QUANTITY','FSC CODE',
     + 'ANNUAL DEMAND VALUE'/
      DATA NAMCAT/'       N-S','       NSO','       R/L',
     + '       R/M','      R/H1','      R/H2','     TOTAL'/
      DATA NAMRND/'DAILY DEMAND','REQUISITION SIZE',
     + 'INTERARRIVAL','REQUISITION PRIORITY','REQUISITION TYPE'/
C
C     GET A SEED VALUE FROM ROUTINE 'GTSEED'
C
      CALL GTSEED(DSEED)
      IMXQTR = 14
C
C     INPUT AND OUTPUT FILE DESCRIPTIONS:
C
C     INPUT FILES:
C
C       UNIT 1) 'GRPDEF.SIM' - CONTAINS GROUPING DEFINITIONS
C       UNIT 2) 'ITEMID.SIM' - CONTAINS GROUP FOR EACH ITEM
C       UNIT 4) 'GRPID.SIM' - CONTAINS CATEGORY LEVELS AND
C               AND SAMPLE COUNTS FOR EACH OF ITGRP GROUPINGS
C       UNIT 7) 'CATACT.DAT' - CONTAINS ACTUAL DMD. FREQ.,
C               AND DEMAND VALUE BY CATEGORY FOR EACH
C               QUARTER
C       UNIT 9) 'CAT81.DAT' - CONTAINS THE CURRENT DEMAND CATEGORY
C               FOR THE ITEMS
C       UNIT 10) 'NSNALL.ID' - CONTAINS THE DEMAND STABILITY
C                VALUES NEEDED IN THE SIMULATION
C       UNIT 11) 'GRPCDF.SIM' - CONTAINS PRIORITY, FMS, AND
C                DAILY DEMAND PROBABILITIES FOR EACH GROUP
C       UNIT 12) 'GRPDST.SIM' - MODELING DISTRIBUTIONS
C                FOR EACH GROUPING
C       UNIT 13) 'MIGACT.DAT' - CONTAINS THE ACTUAL MIGRATION
C                FIGURES FOR 82-1 TO 85-1
C       UNIT 14) 'FSCACT.DAT' - CONTAINS ACTUAL DEMAND,
C                FREQ., AND DEMAND VALUE BY FSC CODE FOR
C                EACH QUARTER
C
C     SETUP FOR MODELING BY READING IN ALL NECESSARY INPUT DATA
```

```
C
C     FIRST READ THE GROUPING DEFINITION FILE 'GRPDEF.SIM'
C
      OPEN(1,FILE='GRPDEF.SIM',STATUS='OLD')
      REWIND 1
C
C      'NTTL' IS THE TITLE FOR THIS RUN
C
      READ(1,501) NTTL
  501 FORMAT(1X,A80)
      WRITE(*,600)
  600 FORMAT('1SIMULATION OF DEMAND FOR DESC INVENTORY ITEMS: ')
      WRITE(*,601) NTTL
  601 FORMAT('0RUN TITLE = ',A80)
C
C     READ THE FIRST DATE FOR DATA COLLECTION
C
      READ(1,531) IFIRST
  531 FORMAT(I5)
C
C     CONVERT TO CONSECUTIVE DATE SINCE 78001
C
      I = IFIRST - 78000
      IYEAR = IYR/1000
      IDAY = I - (IYEAR * 1000)
      IFRSTD = (IYEAR * 365) + IDAY
C
C     ADJUST FOR LEAP YEAR IN 1980 IF PAST FEB28
C
      IF(IFRSTD .GT. 789) THEN
        IFRSTD = IFRSTD - 1
      ENDIF
      WRITE(*,602) IFRSTD, IFIRST
  602 FORMAT('0FIRST DATE FOR DATA COLLECTION = ',I5,
     +      ' JULIAN EQUIVALENT = ',I5)
C
C     READ THE NUMBER OF GROUPS 'IGRP'
C
      READ(1,502) IGRP
  502 FORMAT(I4)
C
C     FOR EACH GROUP, READ THE CORRESPONDING GROUPING VARIABLE
C     AND THE NUMBER OF LEVELS
C
      DO 125 I = 1, IGRP
        READ(1,503) IGROUP(I),ILEVEL(I)
  503   FORMAT(2I4)
C
C       FOR EACH LEVEL, READ THE CUTOFF VALUE
```

```
C
        DO 126 II = 1, ILEVEL(I)
          READ(1,504) XLEVEL(II,I)
  504     FORMAT(F12.4)
  126   CONTINUE
  125 CONTINUE
      CLOSE(1)
C
C     FIGURE TOTAL POSSIBLE GROUPINGS
C
      ITGRP = 1
      DO 130 I = 1, IGRP
        ITGRP = ITGRP * ILEVEL(I)
  130 CONTINUE
      WRITE(*,604) ITGRP
  604 FORMAT('OTOTAL GROUPINGS IN THIS RUN = ',I4)
C
C     FOR EACH POSSIBLE GROUPING, READ THE LEVEL ID AND THE
C     SAMPLE DATA COUNTS FROM UNIT 4
C
      OPEN(4,FILE='GRPID.SIM',STATUS='OLD',
     +  FORM='UNFORMATTED',ACCESS='SEQUENTIAL')
      REWIND 4
      DO 140 I = 1, ITGRP
        READ(4) (BLEVEL(II,I),II=1,IGRP),IGCNT(I)
  140 CONTINUE
      CLOSE(4)
C
C     READ THE ITEM GROUP IDS FROM UNIT 2
C
      OPEN(2,FILE='ITEMID.SIM',STATUS='OLD',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL')
      REWIND 2
      DO 145 I = 1, 40909
        READ(2) JITEM(I)
  145 CONTINUE
      CLOSE(2)
C
C     READ THE PRIORITY, FMS, AND DAILY DEMAND PROBABILITIES
C     FOR EACH GROUPING
C
      OPEN(11,FILE='GRPCDF.SIM',STATUS='OLD',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL',READONLY)
      REWIND 11
      DO 150 I = 1, ITGRP
        READ(11) (XPRIOR(II,I),II=1,3),(FMS(III,I),III=1,3),
     +     (DAILY(I))
  150 CONTINUE
      CLOSE(11)
```

```
      OPEN(12,FILE='GRPDST.SIM',STATUS='OLD')
      REWIND 12
C
C     READ THE MODELING DISTRIBUTIONS FOR EACH GROUP FROM 'GRPDST.SIM'
C
      DO 160 I = 1, ITGRP
        READ(12,*) II
 1201   FORMAT(I2)
        IF(II .EQ. 1) THEN
          LDAILY(I) = .TRUE.
        ELSEIF(II .EQ. 2) THEN
          LDAILY(I) = .FALSE.
        ELSE
          PRINT *,'**ERROR - BAD DISTRIBUTION INPUT (LDAILY)'
        ENDIF
        ICOUNT = 1
  170   CONTINUE
        READ(12,*) IDSTYP(ICOUNT,I)
        IF(IDSTYP(ICOUNT,I).LT.1 .OR. IDSTYP(ICOUNT,I).GT.11) THEN
          PRINT *,'**ERROR - BAD DISTRIBUTION INPUT (IDSTYP)'
        ENDIF
        IF(IDSTYP(ICOUNT,I) .EQ. 1) THEN
          READ(12,1203) NEMPIR(ICOUNT,I)
 1203     FORMAT(A10)
        ELSE
          ISTRT = ((ICOUNT - 1) * 2) + 1
          IEND = ISTRT + 1
          READ(12,*) (XDPARM(II,I),II=ISTRT,IEND)
 1202     FORMAT(2F15.7)
          IF(IDSTYP(ICOUNT,I) .GE. 2 .AND. IDSTYP(ICOUNT,I) .LE. 4) THEN
            READ(12,*) (DMIN(ICOUNT,I))
          ENDIF
        ENDIF
        IF(ICOUNT .EQ. 1 .AND. .NOT. LDAILY(I)) THEN
          ICOUNT = 2
          GO TO 170
        ENDIF
C
C       NOW WRITE THE MODELING INFO. FOR THIS GROUP FOR VERIFICATION
C       PURPOSES
C
        WRITE(*,621) I
  621   FORMAT('0DISTRIBUTION MODELING INFO. FOR GROUP ',I4)
        WRITE(*,629) IGCNT(I)
  629   FORMAT('0NUMBER OF ITEMS IN THIS GROUPING AT ',
     +         'START OF SIMULATION = ',I6)
        WRITE(*,630)
  630   FORMAT('0GROUPING VARIABLE LEVELS ARE: ',/,
     +         3X,'VAR #',2X,'VARIABLE NAME',24X,'GT',11X,'LE'
```

```
      DO 175 II = 1, IGRP
        IF(BLEVEL(II,I) .EQ. 1) THEN
          WRITE(*,631) II,NAMES(IGROUP(II)),
     +      XLEVEL(BLEVEL(II,I),II)
631       FORMAT(3X,I5,') ',A25,22X,F12.3)
        ELSE
          WRITE(*,632) II,NAMES(IGROUP(II)),
     +      XLEVEL(BLEVEL(II,I)-1,II),
     +      XLEVEL(BLEVEL(II,I),II)
632       FORMAT(3X,I5,') ',A25,5X,F12.3,5X,F12.3)
        ENDIF
175   CONTINUE
      IF(LDAILY(I)) THEN
        WRITE(*,622)
622     FORMAT('0TYPE: DAY-TO-DAY SIMULATION')
        WRITE(*,680) XDAILY(I)
680     FORMAT('0PROBABILITY OF POSITIVE DAILY DEMAND = ',F9.7)
        WRITE(*,624) NDNAME(IDSTYP(1,I))
624     FORMAT('0DISTRIBUTION FOR MODELING DAILY DEMAND IS:',A25)
        IF(IDSTYP(1,I) .EQ. 1) THEN
          WRITE(*,625) NEMPIR(1,I)
625       FORMAT(' DATA TAKEN FROM FILE = ',A10)
        ELSE
          WRITE(*,626) (XDPARM(II,I),II=1,2)
626       FORMAT(' PARAMETERS:',2F16.5)
        ENDIF
      ELSE
        WRITE(*,623)
623     FORMAT('0TYPE: NEXT-EVENT SIMULATION')
        WRITE(*,627) NDNAME(IDSTYP(1,I))
627     FORMAT('0DISTRIBUTION FOR MODELING REQUISITION SIZE IS: ',A25)
        IF(IDSTYP(1,I) .EQ. 1) THEN
          WRITE(*,625) NEMPIR(1,I)
        ELSE
          WRITE(*,626) (XDPARM(II,I),II=1,2)
        ENDIF
        WRITE(*,628) NDNAME(IDSTYP(2,I))
628     FORMAT('0DISTRIBUTION FOR MODELING INTERARRIVALS IS: ',A25)
        IF(IDSTYP(2,I) .EQ. 1) THEN
          WRITE(*,625) NEMPIR(2,I)
        ELSE
          WRITE(*,626) (XDPARM(II,I),II=3,4)
        ENDIF
      ENDIF
      WRITE(*,681) (XPRIOR(II,I),II=1,3)
681   FORMAT('0REQUISITION PRIORITY GENERATION CDF PROBABILITIES:'...
     +        I = ',F9.7,     II = ',F9.7,     III = ',F9.7)
      WRITE(*,682) (XPMS(II,I),II=1,3)
682   FORMAT('0REQUISITION TYPE GENERATION CDF PROBABILITIES: ...
```

```
     +     '   NORMAL = ',F9.7,'   MAP/GRANT-AID = ',F9.7,
     +     '   FOREIGN MILITARY SALES = ',F9.7)
  160 CONTINUE
      CLOSE(12)
C
C     READ THE ITEM FSC CODE
C
      OPEN(10,FILE='NSNALL.ID',STATUS='OLD',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL')
      REWIND 10
      DO 182 I = 1, 40909
        READ(10) B1,J1,B2,B3,B4,J2,I1,X1,X2,X3,B5,X4,I2
        BFCODE(I) = B1
  182 CONTINUE
      CLOSE(10)
C
C     READ IN THE AVERAGE REQUISITION SIZE VALUES FOR EACH GROUP
C
      OPEN(13,FILE='AVGSIZ.DAT',STATUS='OLD',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL',READONLY)
      REWIND 13
      DO 174 I = 1, ITGRP
        READ(13) XAVSIZ(I)
  174 CONTINUE
      CLOSE(13)
C
C     OPEN THE ACTUAL MIGRATION DATA FILE
C
      OPEN(13,FILE='MIGACT.DAT',STATUS='OLD',READONLY)
      REWIND 13
C
C     READ IN THE ACTUAL DEMAND, FREQUENCY, AND DEMAND
C     VALUE FIGURES BY DEMAND CATEGORY AND BY FSC CODING
C     FOR EACH QUARTER
C
      OPEN(7,FILE='CATACT.DAT',STATUS='OLD',
     +  FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 7
      OPEN(14,FILE='FSCACT.DAT',STATUS='OLD',
     +  FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 14
      OPEN(8,FILE='FRQACT.DAT',STATUS='OLD',
     +  FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 8
      DO 184 I = 1, 14
        DO 186 II = 1, 4
          READ(7) (XACAT(II,III,I),III=1,7)
          READ(14) (XAFSC(II,III,I),III=1,21)
  186   CONTINUE
```

```
        READ(8) (IAFREQ(II,I),II=1,5)
  184 CONTINUE
      CLOSE(7)
      CLOSE(8)
      CLOSE(14)
C
C     SET ALL NEXT ARRIVALS TO -1.0
C
      DO 188 I = 1, 41000
        XDAYS(I) = -1.0
  188 CONTINUE
C
C     ZERO OUT THE ITEM DATA ARRAYS (XSDMD AND XSFRQ)
C     ZERO OUT THE MIGRATION DATA ARRAY
C
      DO 181 I = 1, 40909
        DO 177 II = 1, 5
          XSDMD(II,I) = 0.0
          XSFRQ(II,I) = 0.0
  177   CONTINUE
        DO 176 II = 1, 15
          BMIG(II,I) = 0
  176   CONTINUE
  181 CONTINUE
C
C     READ IN SIMULATION STARTUP DATA
C
      OPEN(7,FILE='STRTUP.DAT',STATUS='OLD',
     + FORM='UNFORMATTED',ACCESS='SEQUENTIAL',READONLY)
      REWIND 7
      DO 179 I = 1, 40909
        READ(7) XPRICE(I),XSM(1,I),BSTYP(I),BSTAB(1,I),BSTAB(2,I)
        XSM(2,I) = XSM(1,I)
  179 CONTINUE
      CLOSE(7)
C
C     READ IN THE GROUP OBSERVATION COUNTS FOR EACH GROUP
C
      OPEN(7,FILE='GRPOBS.DAT',STATUS='OLD',FORM='UNFORMATTED',
     - ACCESS='SEQUENTIAL',READONLY)
      REWIND 7
      DO 114 I = 1, ITGRP
        READ(7) IGRPOB(1,I)
        READ(7) IGRPOB(2,I)
        READ(7) IGRPOB(3,I)
  114 CONTINUE
C
C     READ IN THE PROBABILITY OF ANY POSITIVE DEMAND FOR
C     AN ITEM IN EACH CATEGORY
```

```
C
      OPEN(7,FILE='GRPPOS.DAT',STATUS='OLD',FORM='UNFORMATTED',
     +  ACCESS='SEQUENTIAL',READONLY)
      REWIND 7
      DO 116 I = 1, ITGRP
        READ(7) XGPOS(I)
  116 CONTINUE
C
C     SET LITEM FOR EACH ITEM BASED ON PROBABILITIES IN XGPOS
C
      DO 117 I = 1, 40909
        CALL GGUBS(DSEED,1,XUNIF)
        IF(XUNIF .LE. XGPOS(JITEM(I))) THEN
          LITEM(I) = .TRUE.
        ELSE
          LITEM(I) = .FALSE.
        ENDIF
  117 CONTINUE
C
C     ZERO OUT RANDOM VARIABLE GENERATION STATS ARRAYS
C
      DO 190 I = 1, ITGRP
        DO 191 II = 1, 4
          IF(II .EQ. 2) THEN
            XSET = 100000.0
          ELSE
            XSET = 0.0
          ENDIF
          XGNDMD(II,1,I) = XSET
          XGNDMD(II,2,I) = XSET
          XGNPRI(II,I) = 0.0
          XGNFMS(II,I) = 0.0
  191   CONTINUE
  190 CONTINUE
C
C     NOW DO THE SIMULATION FOR EACH QUARTER (1 - IMXQTR)
C
      DO 210 IQ = 1, IMXQTR
C
C       ZERO OUT THE QUARTERLY MIGRATION ARRAY (ISCAT)
C
        DO 210 I1 = 1, 7
          DO 220 I2 = 1, 7
            ISCAT(I1,I2) = 0
  220     CONTINUE
  210   CONTINUE
C
C       READ IN THE ACTUAL MIGRATION FIGURES FOR THIS
C       QUARTER
```

```
C
      DO 225 I1 = 1, 7
        READ(13,1301) (IACAT(I1,I2),I2=1,7)
 1301   FORMAT(11X,7I10)
  225 CONTINUE
C
C     ZERO OUT THE QUARTERLY FREQ., QUANTITY, AND VALUE ARRAY
C
      DO 228 I1 = 1, 31
        DO 230 I2 = 1, 4
          IF(I1 .LE. 7) XSCAT(I2,I1,I0) = 0.0
          XSFSC(I2,I1,I0) = 0.0
  230   CONTINUE
  228 CONTINUE
C
C     ZERO OUT GROUPING MIGRATION ARRAYS
C
      DO 232 I1 = 1, ITGRP
        IGOLD(I1) = IGCNT(I1)
        IGOUT(I1) = 0
        IGIN(I1) = 0
  232 CONTINUE
C
C     SAVE CURRENT ITEM GROUPS INTO JITEMO
C
      DO 233 ITEM = 1, 40909
        JITEMO(ITEM) = JITEM(ITEM)
  233 CONTINUE
C
C     MODEL DEMAND FOR EACH GROUPING
C
      DO 300 I1 = 1, ITGRP
        IF(IGCNT(I1) .LT. 1) THEN
          GO TO 300
        ENDIF
C
C       READ IN DATA TO CREATE EMPIRICAL DISTRIBUTIONS
C       FOR THIS GROUPING IF NECESSARY
C
        IF(IDSTYP(1,I1) .EQ. 1) THEN
          IF(LDAIL(I1)) THEN
            IF(IGPROB(1,I1) .EQ. 0) THEN
              GO TO 300
            ENDIF
          ELSE
            IF(IGPROB(2,I1) .EQ. 0) THEN
              GO TO 300
            ENDIF
          ENDIF
```

```
            CALL GETEMP(I1,1)
          ENDIF
          IF(.NOT. LDAILY(I1) .AND. IDSTYP(2,I1) .EQ. 1)
     +      THEN
            IF(IGRPOB(3,I1) .EQ. 0) THEN
              GO TO 300
            ENDIF
            CALL GETEMP(I1,2)
          ENDIF
C
C         MODEL DEMAND FOR EACH ITEM IN THIS GROUPING
C
          DO 400 I2 = 1, 40909
            IF(JITEMO(I2) .NE. I1) THEN
              GO TO 400
            ENDIF
            BMIG(I0,I2) = BSTAB(1,I2)
            CALL DEMAND(DSEED,I0,I1,I2)
C
C           FIGURE THE NEW ITEM GROUPING AND DEMAND
C           CATEGORY MIGRATION
C
            IF(I0 .GE. 4) THEN
              CALL GRPMIG(I0,I1,I2,ITGRP)
            ENDIF
            IF(I1 .EQ. 14) THEN
              BMIG(I0+1,I2) = BSTAB(1,I2)
            ENDIF
  400     CONTINUE
  300   CONTINUE
        IF(I0 .LT. 4) THEN
          PRINT *,
          PRINT *,'DONE WITH SIMULATION FOR QUARTER ',I0
          GO TO 200
        ENDIF
C
C       OUTPUT THE QUARTER SUMMARY HERE
C
        WRITE(*,537) I0
  537   FORMAT('SIMULATION RESULTS FOR QUARTER ',I2
        DO 302 I1 = 1, ITGRP
          WRITE(*,540) I1,IGOLD(I1),IGOUT(I1),IGIN(I1),IGNEW(I1)
  540     FORMAT('ITEM COUNT SUMMARY FOR GROUPING ',I4,
     +      3X,'OLD COUNT = ',I5,'    OUT COUNT = ',I5,
     +      '    INTO COUNT = ',I5,'    NEW COUNT = ',I5)
  302   CONTINUE
        WRITE(*,539) I0
        WRITE(*,542) (NAMCAT(I2),I2=1,7)
  542   FORMAT(' ','COMPARISON OF DEMAND CATEGORY MIGRATION:',/,
```

```
     -    57X, TO',/,13X,'        FROM',7A10)
         DO 500 I1 = 1, 7
           DO 510 I2 = 1, 6
             ISCAT(I1,7) = ISCAT(I1,7) + ISCAT(I1,I2)
 510       CONTINUE
           IF(I1 .EQ. 7) THEN
             DO 515 I2 = 1, 7
               DO 516 I3 = 1, 6
                 ISCAT(I1,I2) = ISCAT(I1,I2) + ISCAT(I3,I2)
 516           CONTINUE
 515         CONTINUE
           ENDIF
           WRITE(*,643) NAMCAT(I1),(ISCAT(I1,I2),I2=1,7)
 643       FORMAT('0   SIMULATED',A10,7I10)
           WRITE(*,644) (IACAT(I1,I2),I2=1,7)
 644       FORMAT(3X,'    ACTUAL',10X,7I10)
           DO 520 I2 = 1, 7
             IWORK(I2) = ISCAT(I1,I2) - IACAT(I1,I2)
             IF(IACAT(I1,I2) .EQ. 0) THEN
               XWORK(I2) = 0.0
             ELSE
               XWORK(I2) = (FLOAT(IWORK(I2))/FLOAT(IACAT(I1,I2))) *
     +           100.0
             ENDIF
 520       CONTINUE
           WRITE(*,645) (IWORK(I2),I2=1,7)
 645       FORMAT(3X,'DIFFERENCE',10X,7I10)
           WRITE(*,646) (XWORK(I2),I2=1,7)
 646       FORMAT(3X,'   PERCENT',10X,7F10.2)
 500     CONTINUE
C
C
C        NOW COMPARE MIGRATION USING PERCENT OF TOTAL STARTING
C        IN CATEGORY AS THE COMPARISON VALUES
C
         WRITE(*,639) I0
         WRITE(*,1642) (NAMCAT(I2),I2=1,6)
1642     FORMAT('0  COMPARISON OF DEMAND CATEGORY MIGRATION: (%)',/,
     -    53X, TO',/,13X,'        FROM',6A10)
         XWORK(50) = 0.0
         DO 1500 I1 = 1, 6
           DO 1501 I2 = 1, 6
             IF(ISCAT(I1,7) .NE. 0) THEN
               XWORK(I2) = FLOAT(ISCAT(I1,I2))/FLOAT(ISCAT(I1,7
             ELSE
               XWORK(I2) = 0.0
             ENDIF
1501       CONTINUE
           WRITE(*,1643) NAMCAT(I1), (XWORK(I2),I2=1,6)
1643       FORMAT('0   SIMULATED',A10,6F10.5)
```

```
          DO 1502 I2 = 1, 6
            IF(IACAT(I1,7) .NE. 0) THEN
              XWORK2(I2) = FLOAT(IACAT(I1,I2))/FLOAT(IACAT(I1,7))
            ELSE
              XWORK2(I2) = 0.0
            ENDIF
1502      CONTINUE
          WRITE(*,1644) (XWORK2(I2),I2=1,6)
1644      FORMAT(3X,'    ACTUAL',10X,6F10.6)
          DO 1503 I2 = 1, 6
            XWORK(I2) = XWORK(I2) - XWORK2(I2)
1503      CONTINUE
          WRITE(*,1645) (XWORK(I2),I2=1,6)
1645      FORMAT(3X,'DIFFERENCE',10X,6F10.6)
          XWORK(7) = 0.0
          DO 1504 I2 = 1, 6
            XWORK(I2) = XWORK(I2)**2
            XWORK(7) = XWORK(7) + XWORK(I2)
1504      CONTINUE
          WRITE(*,1646) (XWORK(I2),I2=1,7)
1646      FORMAT(3X,'DIF-SQUARD',10X,7F10.6)
          XWORK(50) = XWORK(50) + XWORK(7)
1500    CONTINUE
        WRITE(*,1649) XWORK(50)
1649    FORMAT(' TOTAL SQUARED PERCENTAGE DIFFERENCE = ',F15.5)
C
C       COMPARE DEMAND, FREQ., AND DEMAND VALUE BY CATEGORY
C
C
C
C       SUM SIMULATION RESULTS BY DEMAND CATEGORY AND FSC CODE
C
        DO 910 II = 1, 40909
          IC = BSTAB(1,II)
          IF = BFCODE(II)
          XSCAT(1,IC,IO) = XSCAT(1,IC,IO) + XSDMD(5,II)
          XSCAT(2,IC,IO) = XSCAT(2,IC,IO) + XSFRQ(5,II)
          XSCAT(3,IC,IO) = XSCAT(3,IC,IO) + (XSDMD(5,II)
     -      * XPRICE(II))
          XSFSC(1,IF,IO) = XSFSC(1,IF,IO) + XSDMD(5,II)
          XSFSC(2,IF,IO) = XSFSC(2,IF,IO) + XSFRQ(5,II)
          XSFSC(3,IF,IO) = XSFSC(3,IF,IO) + (XSDMD(5,II)
     -      * XPRICE(II))
910     CONTINUE
        DO 920 II = 1, 30
          IF(II .LE. 6) THEN
            XSCAT(4,II,IO) = XSCAT(3,II,IO)
          ENDIF
          XSFSC(4,II,IO) = XSFSC(3,II,IO)
920     CONTINUE
```

```
      WRITE(*,639) I0
      WRITE(*,647)
647   FORMAT('0  COMPARISON OF SIMULATED VS. ACTUAL BY ',
   +    'DEMAND CATEGORY:  (ANNUAL DATA)')
      DO 528 I1 = 1, 4
        DO 529 I2 = 1, 6
          XSCAT(I1,7,I0) = XSCAT(I1,7,I0) + XSCAT(I1,I2,I0)
529     CONTINUE
528   CONTINUE
      DO 530 I1 = 1, 4
        WRITE(*,648) NAMCMP(I1),(NAMCAT(I2),I2=1,7)
648     FORMAT('0  ',A20,7(3X,A10))
        WRITE(*,649) (XSCAT(I1,I2,I0),I2=1,7)
649     FORMAT('0',13X,'SIMULATED',7F13.2)
        WRITE(*,650) (XACAT(I1,I2,I0),I2=1,7)
650     FORMAT(17X,'ACTUAL',7F13.2)
        DO 540 I2 = 1, 7
          XWORK(I2) = XSCAT(I1,I2,I0) - XACAT(I1,I2,I0)
540     CONTINUE
        WRITE(*,651) (XWORK(I2),I2=1,7)
651     FORMAT(13X,'DIFFERENCE',7F13.2)
        DO 550 I2 = 1, 7
          IF(XACAT(I1,I2,I0) .EQ. 0.0) THEN
            XWORK(I2) = 0.0
          ELSE
            XWORK(I2) = (XWORK(I2)/XACAT(I1,I2,I0)) * 100.0
          ENDIF
550     CONTINUE
        WRITE(*,652) (XWORK(I2),I2=1,7)
652     FORMAT(16X,'PERCENT',7F13.2)
530   CONTINUE
C
C     COMPARE DEMAND, FREQ., AND DEMAND VALUE BY FSC CODE
C
      WRITE(*,639) I0
      WRITE(*,653)
653   FORMAT('0  COMPARISON OF SIMULATED VS. ACTUAL BY ',
   +    'FSC CODING:  (ANNUAL DATA)')
      DO 558 I1 = 1, 4
        DO 559 I2 = 1, 30
          XSFSC(I1,31,I0) = XSFSC(I1,31,I0) + XSFSC(I1,I2,I0)
559     CONTINUE
558   CONTINUE
      DO 560 I1 = 1, 4
        WRITE(*,654) NAMCMP(I1)
654     FORMAT('0  ',A20)
        WRITE(*,655) (XSFSC(I1,I2,I0),I2=1,31)
655     FORMAT('0',13X,'SIMULATED',8F13.2,3(/,24X,8F13.2))
        WRITE(*,656) (XAFSC(I1,I2,I0),I2=1,31)
```

```
 656      FORMAT('0',16X,'ACTUAL ',8F13.2,3(/,24X,8F13.2))
          DO 570 I2 = 1, 31
            XWORK(I2) = XSFSC(I1,I2,I0) - XAFSC(I1,I2,I0)
 570      CONTINUE
          WRITE(*,657) (XWORK(I2),I2=1,31)
 657      FORMAT('0',12X,'DIFFERENCE ',8F13.2,3(/,24X,8F13.2))
          DO 580 I2 = 1, 31
            IF(XAFSC(I1,I2,I0) .EQ. 0.0) THEN
              XWORK(I2) = 0.0
            ELSE
              XWORK(I2) = (XWORK(I2)/XAFSC(I1,I2,I0)) * 100.0
            ENDIF
 580      CONTINUE
          WRITE(*,658) (XWORK(I2),I2=1,31)
 658      FORMAT('0',16X,'PERCENT',8F13.2,3(/,24X,8F13.2))
 560    CONTINUE
C
C       OUTPUT COMPARISON OF ITEM COUNTS BY FREQUENCY CATEGORIES
C
        WRITE(*,639) I0
        WRITE(*,801)
 801    FORMAT('0  COMPARISON OF SIMULATED VS. ACTUAL ITEM COUNTS ',
     +    'BY DEMAND FREQUENCY GROUPS:  (ANNUAL DATA)')
        WRITE(*,802)
 802    FORMAT('0',25X,'0',9X,'1-9',7X,'10-19',6X,'20-199',6X,
     +    '200-UP')
C
C       ZERO OUT FREQUENCY GROUPING ARRAY
C
        DO 930 II = 1, 5
          ISFREQ(II,I0) = 0
 930    CONTINUE
        DO 940 II = 1, 40909
          IF(XSFRQ(5,II) .LT. 1.0) THEN
            ISFREQ(1,I0) = ISFREQ(1,I0) + 1
          ELSEIF(XSFRQ(5,II) .LT. 10.0) THEN
            ISFREQ(2,I0) = ISFREQ(2,I0) + 1
          ELSEIF(XSFRQ(5,II) .LT. 20.0) THEN
            ISFREQ(3,I0) = ISFREQ(3,I0) + 1
          ELSEIF(XSFRQ(5,II) .LT. 200.0) THEN
            ISFREQ(4,I0) = ISFREQ(4,I0) + 1
          ELSE
            ISFREQ(5,I0) = ISFREQ(5,I0) + 1
          ENDIF
 940    CONTINUE
        WRITE(*,804) (ISFREQ(II,I0),II=1,5)
 804    FORMAT(5X,'SIMULATED ',5I12)
        WRITE(*,803) (IAFREQ(II,I0),II=1,5)
 803    FORMAT(5X,'ACTUAL    ',5I12)
```

```
      DO 805 II = 1, 5
        IWORK(II) = ISFREQ(II,IO) - IAFREQ(II,IO)
805   CONTINUE
      WRITE(*,806) (IWORK(II),II=1,5)
806   FORMAT(5X,'DIFFERENCE',5I12)
      DO 807 II = 1, 5
        IF(IAFREQ(II,IO) .NE. 0) THEN
          XWORK(II) = (FLOAT(IWORK(II))/FLOAT(IAFREQ(II,IO))) *
     +      100.0
        ELSE
          XWORK(II) = 0.0
        ENDIF
807   CONTINUE
      WRITE(*,808) (XWORK(II),II=1,5)
808   FORMAT(5X,'PERCENT   ',5F12.2)
200 CONTINUE
C
C     WRITE RANDOM VARIATE GENERATION SUMMARY
C
    WRITE(*,660)
660 FORMAT('1RANDOM VARIATE GENERATION SUMMARY BY GROUP:',/,
   +  ' GROUP  DISTRIBUTION          OBSERVATIONS       MINIMUM',
   +  '        MAXIMUM          TOTAL        AVERAGE')
    DO 700 I = 1, ITGRP
      IF(LDAILY(I)) THEN
        IF(XGNDMD(1,1,I) .EQ. 0.0) THEN
          XWORK(1) = 0.0
        ELSE
          XWORK(1) = XGNDMD(4,1,I)/XGNDMD(1,1,I)
        ENDIF
        WRITE(*,661) I,NAMRND(1),(XGNDMD(II,1,I),II=1,4),XWORK(1
661     FORMAT(1X,I5,2X,A20,5F14.4)
      ELSE
        IF(XGNDMD(1,1,I) .EQ. 0.0) THEN
          XWORK(1) = 0.0
        ELSE
          XWORK(1) = XGNDMD(4,1,I)/XGNDMD(1,1,I
        ENDIF
        WRITE(*,661) I,NAMRND(2),(XGNDMD(II,1,I),II=1,4),XWORK(1
        IF(XGNDMD(1,2,I) .EQ. 0.0) THEN
          XWORK(1) = 0.0
        ELSE
          XWORK(1) = XGNDMD(4,2,I)/XGNDMD(1,2,I)
        ENDIF
        WRITE(*,661) I,NAMRND(3),(XGNDMD(II,2,I),II=1,4),XWORK(1)
      ENDIF
700 CONTINUE
C
C     WRITE REQUISITION PRIORITY GENERATION SUMMARY
```

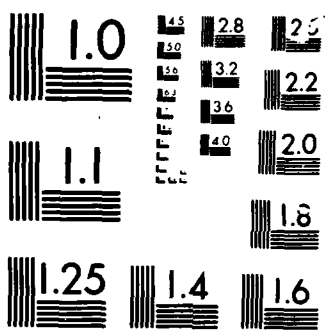
```
C
      WRITE(*,671)
  671 FORMAT('1REQUISITION PRIORITY GENERATION PROBABILITIES ',
     +  ' BY GROUP:',/,
     +  ' GROUP  DISTRIBUTION          OBSERVATIONS              I',
     +  '                II             III        AVERAGE')
      DO 710 I = 1, ITGRP
        IF(XGNPRI(4,I) .EQ. 0.0) THEN
          XWORK(1) = 0.0
        ELSE
          XWORK(1) = (XGNPRI(1,I) * 1.0) + (XGNPRI(2,I) * 2.0) +
     +      (XGNPRI(3,I) * 3.0)
          XWORK(1) = XWORK(1)/XGNPRI(4,I)
          DO 720 II = 1, 3
            XGNPRI(II,I) = XGNPRI(II,I)/XGNPRI(4,I)
  720     CONTINUE
        ENDIF
        WRITE(*,672) I,NAMRND(4),XGNPRI(4,I),(XGNPRI(II,I),II=1,3),
     +    XWORK(1)
  672   FORMAT(1X,I5,2X,A20,F14.0,4F14.7)
  710 CONTINUE
C
C     WRITE REQUISITION TYPE GENERATION SUMMARY
C
      WRITE(*,673)
  673 FORMAT('1REQUISITION TYPE GENERATION PROBABILITIES ',
     +  ' BY GROUP:',/,
     +  ' GROUP  DISTRIBUTION          OBSERVATIONS         NORMAL',
     +  '           MAP/G-A            FMS        AVERAGE')
      DO 730 I = 1, ITGRP
        IF(XGNFMS(4,I) .EQ. 0.0) THEN
          XWORK(1) = 0.0
        ELSE
          XWORK(1) = (XGNFMS(1,I) * 0.0) + (XGNFMS(2,I) * 1.0) +
     +      (XGNFMS(3,I) * 2.0)
          XWORK(1) = XWORK(1)/XGNFMS(4,I)
          DO 740 II = 1, 3
            XGNFMS(II,I) = XGNFMS(II,I)/XGNFMS(4,I)
  740     CONTINUE
        ENDIF
        WRITE(*,672) I,NAMRND(5),XGNFMS(4,I),(XGNFMS(II,I),II=1,3),
     +    XWORK(1)
  730 CONTINUE
C
C     COMPUTE THE MIGRATION MEASURES FOR EACH ITEM, SORT THE VALUES,
C     AND SAVE TO A DATA FILE
C
      DO 749 I = 1, 6
        IJUMP(I) = 0
```

```
  749 CONTINUE
      DO 750 I = 1, 40909
        XBMIG(I) = 0.0
        DO 760 II = 5, 14
          IVAL = BMIG(II-1,I) - BMIG(II,I)
          IJUMP(IABS(IVAL)+1) = IJUMP(IABS(IVAL)+1) + 1
          XBMIG(I) = XBMIG(I) + (FLOAT(IVAL)**2)
  760   CONTINUE
        LGOOD = .TRUE.
        BSTBIL(I) = 1
        DO 770 II = 1, 10
          IVAL = 14 - II
          IF(LGOOD) THEN
            IF(BMIG(14,I) .EQ. BMIG(IVAL,I)) THEN
              BSTBIL(I) = BSTBIL(I) + 1
            ELSE
              LGOOD = .FALSE.
            ENDIF
          ENDIF
  770   CONTINUE
  750 CONTINUE
C
C     SORT THE VALUES IN XBMIG
C
      ISORT = 40909
      CALL VSRTA(XBMIG,ISORT)
C
C     WRITE THESE VALUES TO A FILE
C
      OPEN(15,FILE='MIGVAL.SIM',STATUS='NEW')
      DO 780 I = 1, 40909, 10
        WRITE(15,1591) XBMIG(I)
 1591   FORMAT(F5.0)
  780 CONTINUE
      CLOSE(15)
C
C     CALCULATE STABILITY COUNTS
C
      DO 790 I = 1, 11
        ISTCNT(I) = 0
  790 CONTINUE
      DO 795 I = 1, 40909
        ISTCNT(BSTBIL(I)) = ISTCNT(BSTBIL(I)) + 1
  795 CONTINUE
      OPEN(15,FILE='STBCNT.SIM',STATUS='NEW')
      DO 796 I = 1, 11
        WRITE(15,1592) I,ISTCNT(I)
 1592   FORMAT(I3,I7)
  796 CONTINUE
```

```
      CLOSE(15)
      OPEN(15,FILE='STBJMP.SIM',STATUS='NEW')
      DO 797 I = 1, 6
        WRITE(15,1593) I-1,IJUMP(I)
 1593   FORMAT(I2,I10)
  797 CONTINUE
      CLOSE(15)
C
C     DONE WITH THE SIMULATION, SO CLEAN UP AND STOP PROGRAM
C
      CLOSE(13)
      STOP
      END
      SUBROUTINE DEMAND(DSEED,I0,I1,I2)
C
C     GENERATE ONE QUARTERS WORTH OF DEMAND FOR AN ITEM
C
C       DSEED - THE CURRENT RANDOM NUMBER SEED VALUE
C       I0 - THE CURRENT QUARTER NUMBER (1-IMXQTR)
C       I1 - THE CURRENT GROUP NUMBER (1-ITGRP)
C       I2 - THE CURRENT ITEM NUMBER (1-40909)
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/ONEDMD/XDTOT,XDMIN,XDMAX,IFCNT,XDFMS,XDPRI,XDMD91(91)
      COMMON/ITMDAT/JITEM(41000),XDAYS(41000),LITEM(41000),
     +  XPRICE(41000)
      COMMON/SIMDAT/XPRIOR(3,1000),XFMS(3,1000),XDPARM(4,1000),
     +  XDAILY(1000),IDSTYP(2,1000),LDAILY(1000)
      COMMON/DMDFRQ/ISFREQ(5,14),IAFREQ(5,14),XAVSIZ(1000)
      IFCNT = 0
      XDMIN = 100000.0
      XDMAX = 0.0
      XDTOT = 0.0
      XDFMS = 0.0
      XDPRI = 0.0
      DO 10 I = 1, 91
        XDMD91(I) = 0.0
   10 CONTINUE
      IF(LDAILY(I1)) THEN
C
C       GENERATE DEMANDS USING DAY-TO-DAY SIMULATION
C
C       CHECK TO BE SURE THIS IS NOT AN ITEM WHICH HAS SWITCHED
C       FROM NEXT-EVENT TO DAILY GENERATION
C
        IF(XDAYS(I2) .GE. 0.0) THEN
          IF(XDAYS(I2) .LT. 91) THEN
            ISTRT = INT(XDAYS(I2)) + 1
```

AD-A167 126 ESTIMATION OF INVENTORY ITEM DEMAND DISTRIBUTIONS: MODELING ITEM MIGRATIO..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH K P SMITH DEC 85 3/4

UNCLASSIFIED AFIT/GOR/OS/85S-18 F/G 15/5 NL



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```
            XDAYS(I2) = -1.0
          ELSE
            XDAYS(I2) = XDAYS(I2) - 91.0
            GO TO 999
          ENDIF
        ELSE
          ISTRT = 1
        ENDIF
        DO 100 I = ISTRT, 91
          CALL GGUBS(DSEED,1,XUNIF)
          IF(XUNIF .LE. XDAILY(I1)) THEN
            CALL GENDMD(DSEED,IDSTYP(1,I1),I1,1,XDMD)
            XDMD91(I) = XDMD
            XDTOT = XDTOT + XDMD
            IF(XDMD .GT. 1.0) THEN
C
C             FIGURE REQUISITION FREQUENCY FOR THIS DAILY DEMAND
C
              XSIZ = XDMD/XAVSIZ(I1)
              IFRQ = INT(XSIZ + 0.5)
              IF(IFRQ .LT. 1) THEN
                IFRQ = 1
              ENDIF
            ELSE
              IFRQ = 1
            ENDIF
            IFCNT = IFCNT + IFRQ
            IF(XDMD .GT. XDMAX) THEN
              XDMAX = XDMD
            ENDIF
            IF(XDMD .LT. XDMIN) THEN
              XDMIN = XDMD
            ENDIF
            CALL GENPRI(DSEED,I1,ZPRI)
            XDPRI = XDPRI + (ZPRI * FLOAT(IFRQ))
            CALL GENFMS(DSEED,I1,ZFMS)
            XDFMS = XDFMS + (ZFMS * FLOAT(IFRQ))
          ENDIF
  100   CONTINUE
      ELSE
C
C       GENERATE DEMAND USING NEXT-EVENT SIMULATION
C
        IF(.NOT. LITEM(I2)) THEN
          GO TO 999
        ENDIF
        IF(XDAYS(I2) .LT. 0.0) THEN
          CALL GENDMD(DSEED,IDSTYP(2,I1),I1,2,XDAYS(I2))
        ENDIF
```

```
  200   CONTINUE
        IF(XDAYS(I2) .LT. 91.0) THEN
          CALL GENDMD(DSEED,IDSTYP(1,I1),I1,1,XDMD)
          IDAY = INT(XDAYS(I2)) + 1
          XDMD91(IDAY) = XDMD
          XDTOT = XDTOT + XDMD
          IFCNT = IFCNT + 1
          IF(XDMD .GT. XDMAX) THEN
            XDMAX = XDMD
          ENDIF
          IF(XDMD .LT. XDMIN) THEN
            XDMIN = XDMD
          ENDIF
          CALL GENPRI(DSEED,I1,ZPRI)
          XDPRI = XDPRI + ZPRI
          CALL GENFMS(DSEED,I1,ZFMS)
          XDFMS = XDFMS + ZFMS
          CALL GENDMD(DSEED,IDSTYP(2,I1),I1,2,XNEXT)
          XDAYS(I2) = XDAYS(I2) + XNEXT
          GO TO 200
        ELSE
          XDAYS(I2) = XDAYS(I2) - 91.0
        ENDIF
      ENDIF
  999 CONTINUE
      CALL SMOOTH(I2)
      CALL UPDATE(I0,I2,XDTOT,IFCNT)
      RETURN
      END
      SUBROUTINE GENDMD(DSEED,INDIST,IN1,IN2,XDMD)
C
C     GENERATE A RANDOM DEMAND VALUE
C
C     CALLING PARAMETERS:
C       DSEED - THE CURRENT RANDOM NUMBER SEED
C       INDIST - THE TYPE OF DISTRIBUTION TO GENERATED FROM
C         1 = EMPIRICAL
C         2 = EXPONENTIAL
C         3 = WEIBULL
C         4 = GAMMA
C         5 = UNIFORM
C         6 = NORMAL
C         7 = ERLANG
C         8 = TRIANGULAR
C         9 = GEOMETRIC
C        10 = POISSON
C        11 = DISCRETE-UNIFORM
C       IN1 - THE CURRENT GROUPING (1 - ITGRP)
C       IN2 - THE TYPE OF VALUE GENERATED
```

```
C          1 = DAILY DEMAND OR REQUISITION SIZE
C          2 = INTERARRIVAL
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/EMPIR/XCDF(2,20000),XCTOFF(2,20000),
     +  ICTOFF(2)
      COMMON/GRPDMD/XGNDMD(4,2,1000),XGNPRI(4,1000),XGNFMS(4,1000)
      COMMON/SIMDAT/XPRIOR(3,1000),XFMS(3,1000),XDPARM(4,1000),
     +  XDAILY(1000),IDSTYP(2,1000),LDAILY(1000)
      COMMON/DMDFRQ/ISFREQ(5,14),IAFREQ(5,14),XAVSIZ(1000),XDMIN(2,1000)
      DIMENSION XWORK(2)
      IF(INDIST .EQ. 1) THEN
C
C       GENERATE DEMAND FROM THE EMPIRICAL DISTRIBUTION
C
        CALL GGUBS(DSEED,1,XUNIF)
        IPOS = 0
  100   CONTINUE
        IPOS = IPOS + 1
        IF(XUNIF .GT. XCDF(IN2,IPOS)) GO TO 100
        IF(IPOS .GT. 1) THEN
          XDIFF = XCTOFF(IN2,IPOS) - XCTOFF(IN2,IPOS-1)
          IF(XDIFF .NE. 1.0) THEN
            XPART = XUNIF - XCDF(IN2,IPOS-1)
            XTOT = XCDF(IN2,IPOS) - XCDF(IN2,IPOS-1)
            XDMD = XCTOFF(IN2,IPOS-1) + ANINT((XPART/XTOT)
     +         * XDIFF)
          ELSE
            XDMD = XCTOFF(IN2,IPOS)
          ENDIF
        ELSE
          XDMD = XCTOFF(IN2,IPOS)
        ENDIF
      ELSEIF(INDIST .EQ. 2) THEN
C
C       GENERATE DEMAND FROM EXPONENTIAL DISTRIBUTION
C         XDPARM(1 OR 3,IN1) = EXPONENTIAL PARAMETER
C
        IF(IN2 .EQ. 1) THEN
          CALL GGEXN(DSEED,XDPARM(1,IN1),1,XDMD)
        ELSE
          CALL GGEXN(DSEED,XDPARM(3,IN1),1,XDMD)
        ENDIF
        XDMD = AINT(XDMD) + XDMIN(IN2,IN1)
      ELSEIF(INDIST .EQ. 3) THEN
C
C       GENERATE DEMAND FROM WEIBULL DISTRIBUTION
C         XDPARM(1 OR 3,IN1) = SCALE PARAMETER
```

```
C          XDPARM(2 OR 4,IN1) = SHAPE PARAMETER
C
          IF(IN2 .EQ. 1) THEN
            CALL GGWIB(DSEED,XDPARM(2,IN1),1,XDMD)
            XDMD = XDMD * XDPARM(1,IN1)
          ELSE
            CALL GGWIB(DSEED,XDPARM(4,IN1),1,XDMD)
            XDMD = XDMD * XDPARM(3,IN1)
          ENDIF
          XDMD = AINT(XDMD) + XDMIN(IN2,IN1)
        ELSEIF(INDIST .EQ. 4) THEN
C
C         GENERATE DEMAND FROM GAMMA DISTRIBUTION
C           XDPARM(1 OR 3,IN1) = SCALE PARAMETER
C           XDPARM(2 OR 4,IN1) = SHAPE PARAMETER
C
          IF(IN2 .EQ. 1) THEN
            CALL GGAMR(DSEED,XDPARM(2,IN1),1,XWORK,XDMD)
            XDMD = XDMD * XDPARM(1,IN1)
          ELSE
            CALL GGAMR(DSEED,XDPARM(4,IN1),1,XWORK,XDMD)
            XDMD = XDMD * XDPARM(3,IN1)
          ENDIF
          XDMD = AINT(XDMD) + XDMIN(IN2,IN1)
        ELSEIF(INDIST .EQ. 5) THEN
C
C         GENERATE DEMAND FROM UNIFORM DISTRIBUTION
C           XDPARM(1 OR 3,IN1) = MINIMUM VALUE
C           XDPARM(2 OR 4,IN1) = MAXIMUM VALUE
C
          IF(IN2 .EQ. 1) THEN
            CALL GGUBS(DSEED,1,XUNIF)
            XDMD = (XUNIF * XDPARM(2,IN1)) + ((1.0 - XUNIF) *
     +        XDPARM(1,IN1))
          ELSE
            CALL GGUBS(DSEED,1,XUNIF)
            XDMD = (XUNIF * XDPARM(4,IN1)) + ((1.0 - XUNIF) *
     +        XDPARM(3,IN1))
          ENDIF
          XDMD = AINT(XDMD) + 1.0
        ELSEIF(INDIST .EQ. 9) THEN
C
C         GENERATE DEMAND FROM GEOMETRIC DISTRIBUTION
C           XDPARM(1 OR 3,IN2) = GEOMETRIC PARAMETER
C           XDPARM(2 OR 4,IN2) = MINIMUM EMPIRICAL VALUE
C
          IF(IN2 .EQ. 1) THEN
            CALL GGEOT(DSEED,1,XDPARM(1,IN1),XWORK,IDMD)
            XDMD = FLOAT(IDMD) + XDPARM(2,IN1)
```

```
          ELSE
            CALL GGEOT(DSEED,1,XDPARM(3,IN1),XWORK,IDMD)
            XDMD = FLOAT(IDMD) + XDPARM(4,IN1)
          ENDIF
        ELSEIF(INDIST .EQ. 10) THEN
C
C         GENERATE DEMAND FROM POISSON DISTRIBUTION
C           XDPARM(1 OR 3,IN2) = POISSON PARAMETER
C           XDPARM(2 OR 4,IN2) = MINIMUM EMPIRICAL VALUE
C
          IF(IN2 .EQ. 1) THEN
            CALL GGPOS(XDPARM(1,IN1),DSEED,1,IDMD,IER)
            XDMD = FLOAT(IDMD) + XDPARM(2,IN1)
          ELSE
            CALL GGPOS(XDPARM(3,IN1),DSEED,1,IDMD,IER)
            XDMD = FLOAT(IDMD) + XDPARM(4,IN1)
          ENDIF
          IF(IER .EQ. 129) THEN
            PRINT *,'**ERROR - INCORRECT PARAMETER TO IMSL ROUTINE',
     +         ' (GGPOS)'
          ENDIF
        ELSEIF(INDIST .EQ. 11) THEN
C
C         GENERATE DEMAND FROM DISCRETE-UNIFORM DISTRIBUTION
C           XDPARM(1 OR 3,IN2) = MINIMUM EMPIRICAL VALUE
C           XDPARM(2 OR 4,IN2) = MAXIMUM EMPIRICAL VALUE
C
          IF(IN2 .EQ. 1) THEN
            IRANGE = (INT(XDPARM(2,IN1)) - INT(XDPARM(1,IN1))) + 1
            CALL GGUD(DSEED,IRANGE,1,IDMD)
            XDMD = FLOAT(IDMD) + (XDPARM(1,IN1) - 1.0)
          ELSE
            IRANGE = (INT(XDPARM(4,IN1)) - INT(XDPARM(3,IN1))) + 1
            CALL GGUD(DSEED,IRANGE,1,IDMD)
            XDMD = FLOAT(IDMD) + (XDPARM(3,IN1) - 1.0)
          ENDIF
        ELSE
          PRINT *,'**ERROR - BAD DISTRIBUTION # IN (GENDMD)'
          XDMD = 0.0
        ENDIF
C
C       UPDATE DEMAND/SIZE/ARRIVAL GENERATION ARRAY (XGNDMD)
C
        XGNDMD(1,IN2,IN1) = XGNDMD(1,IN2,IN1) + 1.0
        IF(XDMD .LT. XGNDMD(2,IN2,IN1)) THEN
          XGNDMD(2,IN2,IN1) = XDMD
        ENDIF
        IF(XDMD .GT. XGNDMD(3,IN2,IN1)) THEN
          XGNDMD(3,IN2,IN1) = XDMD
```

```
      ENDIF
      XGNDMD(4,IN2,IN1) = XGNDMD(4,IN2,IN1) + XDMD
      RETURN
      END
      SUBROUTINE GENPRI(DSEED,IGRP,ZPRI)
C
C     GENERATE A PRIORITY LEVEL FOR A DEMAND FROM GROUP = IGRP
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/GRPDMD/XGNDMD(4,2,1000),XGNPRI(4,1000),XGNFMS(4,1000)
      COMMON/SIMDAT/XPRIOR(3,1000),XFMS(3,1000),XDPARM(4,1000),
     +  XDAILY(1000),IDSTYP(2,1000),LDAILY(1000)
      CALL GGUBS(DSEED,1,XUNIF)
      IF(XUNIF .LE. XPRIOR(1,IGRP)) THEN
        ZPRI = 1.0
      ELSEIF(XUNIF .LE. XPRIOR(2,IGRP)) THEN
        ZPRI = 2.0
      ELSE
        ZPRI = 3.0
      ENDIF
C
C     UPDATE THE PRIORITY GENERATION ARRAY (XGNPRI)
C
      IPOS = INT(ZPRI)
      XGNPRI(IPOS,IGRP) = XGNPRI(IPOS,IGRP) + 1.0
      XGNPRI(4,IGRP) = XGNPRI(4,IGRP) + 1.0
      RETURN
      END
      SUBROUTINE GENFMS(DSEED,IGRP,ZFMS)
C
C     GENERATE AN FMS CODE FOR A DEMAND FROM GROUP = IGRP
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/GRPDMD/XGNDMD(4,2,1000),XGNPRI(4,1000),XGNFMS(4,1000)
      COMMON/SIMDAT/XPRIOR(3,1000),XFMS(3,1000),XDPARM(4,1000),
     +  XDAILY(1000),IDSTYP(2,1000),LDAILY(1000)
      CALL GGUBS(DSEED,1,XUNIF)
      IF(XUNIF .LE. XFMS(1,IGRP)) THEN
        ZFMS = 0.0
      ELSEIF(XUNIF .LE. XFMS(2,IGRP)) THEN
        ZFMS = 1.0
      ELSE
        ZFMS = 2.0
      ENDIF
C
C     UPDATE THE FMS CODE GENERATION ARRAY (XGNFMS)
C
```

```
      IPOS = INT(ZFMS) + 1
      XGNFMS(IPOS,IGRP) = XGNFMS(IPOS,IGRP) + 1.0
      XGNFMS(4,IGRP) = XGNFMS(4,IGRP) + 1.0
      RETURN
      END
      SUBROUTINE GETEMP(INGRP,INDIST)
C
C     READ IN AND PROCESS THE DATA TO CREATE AN EMPIRICAL CDF
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/EMPIR/XCDF(2,20000),XCTOFF(2,20000),
     +  ICTOFF(2)
      COMMON/SIMDAT/XPRIOR(3,1000),XFMS(3,1000),XDPARM(4,1000),
     +  XDAILY(1000),IDSTYP(2,1000),LDAILY(1000)
      COMMON/NAMEMP/NEMPIR(2,1000)
      CHARACTER *10 NEMPIR
      OPEN(15,FILE=NEMPIR(INDIST,INGRP),
     +  STATUS='OLD',FORM='UNFORMATTED',ACCESS='SEQUENTIAL')
      REWIND 15
      ICTOFF(INDIST) = 0
      XTOT = 0.0
  200 CONTINUE
      READ(15,END=300) ICUT,INUM
      ICTOFF(INDIST) = ICTOFF(INDIST) + 1
      XCTOFF(INDIST,ICTOFF(INDIST)) = FLOAT(ICUT)
      XCDF(INDIST,ICTOFF(INDIST)) = FLOAT(INUM)
      XTOT = XTOT + FLOAT(INUM)
      GO TO 200
  300 CONTINUE
      CLOSE(15)
      IF(ICTOFF(INDIST) .EQ. 0) THEN
        PRINT *,'**ERROR - NO EMPIRICAL DATA READ IN (GETEMP)'
        XCTOFF(INDIST,1) = 0.0
        ICTOFF(INDIST) = 1
        GO TO 999
      ENDIF
C
C     SORT THE CUTOFF VALUES IN ASCENDING ORDER
C
      IF(ICTOFF(INDIST) .EQ. 1) THEN
        GO TO 999
      ENDIF
      DO 310 I = 1, ICTOFF(INDIST) - 1
        DO 320 II = I+1, ICTOFF(INDIST)
          IF(XCTOFF(INDIST,II) .LT. XCTOFF(INDIST,I)) THEN
            XSAV = XCTOFF(INDIST,I)
            XCTOFF(INDIST,I) = XCTOFF(INDIST,II)
            XCTOFF(INDIST,II) = XSAV
```

```
            XSAV = XCDF(INDIST,I)
            XCDF(INDIST,I) = XCDF(INDIST,II)
            XCDF(INDIST,II) = XSAV
          ENDIF
  320   CONTINUE
  310 CONTINUE
C
C     FIGURE THE PROBABILITIES
C
      X = 0.0
      DO 330 I = 1, ICTOFF(INDIST)
        X = X + XCDF(INDIST,I)
        XCDF(INDIST,I) = X/XTOT
  330 CONTINUE
  999 CONTINUE
      XCDF(INDIST,ICTOFF(INDIST)) = 1.0
      RETURN
      END
      SUBROUTINE GRPMIG(I0,I1,I2,ITGRP)
C
C     FIGURE THE NEW ITEM GROUPING (IF IT HAS CHANGED) AND
C     THE DEMAND CATEGORY MIGRATION FOR ITEM # I2
C
C     PARAMETER DEFINITIONS:
C
C       I0 - THE CURRENT QUARTER NUMBER
C       I1 - THE CURRENT GROUPING NUMBER
C       I2 - THE CURRENT ITEM NUMBER
C       ITGRP - THE TOTAL NUMBER OF DATA GROUPS
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), LOGICAL (L), CHARACTER (N)
      COMMON/GROUP/IGROUP(11),XLEVEL(100,11),IGRP,ILEVEL(11)
      COMMON/SIMDAT/XPRIOR(3,1000),XFMS(3,1000),XDPARM(4,1000),
     +  XDAILY(1000),IDSTYP(2,1000),LDAILY(1000)
      COMMON/ITMDAT/JITEM(41000),XDAYS(41000),LITEM(41000),
     +  XPRICE(41000),BSTAB(2,41000),BFCODE(41000)
      COMMON/GRPDAT/IGCNT(1000),IGOLD(1000),IGOUT(1000),IGIN(1000),
     +  BLEVEL(11,1000)
      COMMON/MIGRAT/IACAT(7,7),ISCAT(7,7)
      COMMON/DEMAND/XACAT(4,7,14),XSCAT(4,7,14),XAFSC(4,31,14),
     +  XSFSC(4,31,14)
      COMMON/GRPDMD/XGNDMD(4,2,1000),XGNPRI(4,1000),XGNFMS(4,1000)
      COMMON/ONEDMD/XDTOT,XDMIN,XDMAX,IFCNT,XDFMS,XDPRI,XDMD91(91)
      COMMON/DMDFRQ/ISFREQ(5,14),IAFREQ(5,14),XAVSIZ(1000)
      COMMON/SMOOTH/XSM(2,41000),XSDMD(5,41000),XSFRQ(5,41000),
     +  BSTYP(41000)
      COMMON/MIGSAV/BMIG(15,41000),XBMIG(41000),BSTBIL(41000),
     +  ISTCNT(20),IJUMP(20)
```

DEMAND SIMULATION PROGRAM SOURCE CODE

```
      DIMENSION XITEM(11),XDOLD(3),XFOLD(3)
      DIMENSION BLEV(11)
C
C     PUT THE ITEM GROUPING DATA INTO XITEM(1 - 11)
C
      DATA IERR1/0/, IERR2/0/
      DATA IERR/0/
      XITEM(1) = FLOAT(IFCNT)
      XITEM(3) = XDMAX
      IF(XITEM(1) .NE. 0.0) THEN
        XITEM(4) = XDTOT/XITEM(1)
        XITEM(6) = XDPRI/XITEM(1)
        XITEM(7) = XDFMS/XITEM(1)
      ELSE
        XITEM(4) = 0.0
        XITEM(6) = 0.0
        XITEM(7) = 0.0
      ENDIF
      XITEM(8) = XPRICE(I2)
      ICODE = BFCODE(I2)
      XITEM(10) = FLOAT(ICODE)
C
C     SET THE ANNUAL DEMAND QUANTITY AND ANNUAL DEMAND FREQUENCY
C
      XITEM(1) = XSFRQ(5,I2)
      XITEM(9) = XSDMD(5,I2)
C
C     COMPUTE THE ANNUAL DEMAND VALUE
C
      XITEM(11) = XITEM(9) * XITEM(8)
C
C     COMPUTE NEW ITEM DEMAND CATEGORY
C
      CALL QFD(I2,XAFD,XAFDV,XFRQ)
      IF((XAFDV .GE. 20.0) .AND. (XAFD .GE. 12.0) .AND.
     +   (XFRQ .GE. 3.0)) THEN
C
C       REPLENISHMENT CATEGORIES
C
        IF(XAFDV .LT. 400.0) THEN
C
C         REPLENISHMENT/LOW
C
          BNEW = 3
        ELSEIF(XAFDV .LT. 4500.0) THEN
C
C         REPLENISHMENT/MEDIUM
C
          BNEW = 4
```

```
          ELSEIF(XAFDV .LT. 15000.0) THEN
C
C           REPLENISHMENT/HIGH 1
C
            BNEW = 5
          ELSE
C
C           REPLENISHMENT/HIGH 2
C
            BNEW = 6
          ENDIF
        ELSE
C
C         NSO/NON-STOCKED ITEMS
C
          IF(BSTAB(1,I2) .NE. 1) THEN
C
C           NSO ITEM
C
            BNEW = 2
          ELSE
C
C           HAVE IT REMAIN NON-STOCKED
C
            BNEW = 1
          ENDIF
        ENDIF
C
C       CHECK FOR MIGRATION NOT ALLOWED IN THE DESC SYSTEM
C
        IF(BNEW .LT. 3) THEN
C
C         ITEM CANNOT HAVE MIGRATED UP FROM NSO OR NON-STOCKED OVER
C         PREVIOUS THREE QUARTERS
C
          IF(BMIG(I0,I2) .GE. 3) THEN
            IF((BMIG(I0-1,I2) .LT. 3) .OR. (BMIG(I0-2,I2) .LT. 3) .OR.
     +        (BMIG(I0-3,I2) .LT. 3)) THEN
C
C             DO NOT ALLOW THIS MIGRATION
C
              BNEW = BSTAB(1,I2)
            ENDIF
          ENDIF
        ENDIF
C
C       CHECK FOR MIGRATION AMONG DEMAND CATEGORIES
C
        IFROM = BSTAB(1,I2)
```

```
      ITO = BNEW
      ISCAT(IFROM,ITO) = ISCAT(IFROM,ITO) + 1
      IF(IFROM .NE. ITO) THEN
        BSTAB(2,I2) = 1
      ELSE
        BSTAB(2,I2) = BSTAB(2,I2) + 1
        IF(BSTAB(2,I2) .GT. 9) THEN
          BSTAB(2,I2) = 9
        ENDIF
      ENDIF
      IF(BSTAB(1,I2) .LT. 3 .AND. BNEW .GE. 3) THEN
C
C       MIGRATION FROM NON-REPLENISHMENT TO REPLENISHMENT
C       HAS OCCURED SO COMPUTE THE NEW SMOOTHING FACTORS
C       FOR THIS ITEM
C
        IF(XFRQ .GE. 200.0) THEN
          BSTYP(I2) = 2
          XSM(1,I2) = XAFD/12.0
        ELSE
          BSTYP(I2) = 1
          XSM(1,I2) = XAFD/4.0
        ENDIF
        XSM(2,I2) = XSM(1,I2)
      ENDIF
      IF(BSTAB(1,I2) .GE. 3 .AND. BNEW .LT. 3) THEN
C
C       OPPOSITE MIGRATION HAS OCCURRED
C
        BSTYP(I2) = 0
      ENDIF
      BSTAB(1,I2) = BNEW
      XITEM(2) = FLOAT(ITO)
      ICODE = BSTAB(2,I2)
      XITEM(5) = FLOAT(ICODE)
C
C     CHECK TO BE SURE PROPER FORECASTING TECHNIQUE
C     IS BEING USED, ALTER IF NOT
C
      IF(BSTYP(I2) .EQ. 2) THEN
        IF(XSFRQ(5,I2) .LT. 200.0) THEN
          XSM(1,I2) = XSM(1,I2) * 3.0
          XSM(2,I2) = XSM(2,I2) * 3.0
          BSTYP(I2) = 1
        ENDIF
      ELSEIF(BSTYP(I2) .EQ. 1) THEN
        IF(XSFRQ(5,I2) .GE. 200.0) THEN
          XSM(1,I2) = XSM(1,I2)/3.0
          XSM(2,I2) = XSM(2,I2)/3.0
```

```
            BSTYP(I2) = 2
          ENDIF
        ENDIF
C
C       FIGURE OUT THE GROUPING VARIABLE LEVELS FOR
C       THIS ITEM
C
        DO 200 I = 1, IGRP
          III = IGROUP(I)
          DO 210 II = 1, ILEVEL(I)
            IF(II .EQ. 1) THEN
              IF(XITEM(III) .LE. XLEVEL(II,I)) THEN
                BLEV(I) = II
              ENDIF
            ELSE
              IF(XITEM(III) .GT. XLEVEL(II-1,I) .AND.
     +           XITEM(III) .LE. XLEVEL(II,I)) THEN
                BLEV(I) = II
              ENDIF
            ENDIF
  210     CONTINUE
  200   CONTINUE
C
C       NOW FIGURE OUT WHICH GROUP THE ITEMS BELONGS IN
C
        INEW = 0
        DO 300 I = 1, ITGRP
          LGOOD = .TRUE.
          DO 310 II = 1, IGRP
            IF(BLEV(II) .NE. BLEVEL(II,I)) THEN
              LGOOD = .FALSE.
            ENDIF
  310     CONTINUE
          IF(LGOOD) THEN
C
C           THE CATEGORY HAS BEEN FOUND
C
            IF(INEW .NE. 0) THEN
              IERR = IERR + 1
              IF(IERR .LE. 100) THEN
                PRINT *,'**ERROR IN "GRPMIG", FOUND SECOND GROUPING ',
     +            'FOR ITEM # ',I2
              ENDIF
            ENDIF
            INEW = I
            IF(INEW .NE. JITEM(I2)) THEN
C
C             A CHANGE OF CATEGORY HAS OCCURED FOR THIS ITEM
C
```

```
              IGCNT(JITEM(I2)) = IGCNT(JITEM(I2)) - 1
              IGOUT(JITEM(I2)) = IGOUT(JITEM(I2)) + 1
              IGCNT(INEW) = IGCNT(INEW) + 1
              IGIN(INEW) = IGIN(INEW) + 1
              JITEM(I2) = INEW
            ENDIF
          ENDIF
  300 CONTINUE
      IF(INEW .EQ. 0) THEN
        IERR2 = IERR2 + 1
        IF(IERR2 .LE. 100) THEN
          PRINT *,'**ERROR IN "GRPMIG", NO NEW GROUPING FOUND ',
     +       'FOR ITEM # ',I2
        ENDIF
      ENDIF
      RETURN
      END
      SUBROUTINE SMOOTH(ITEM)
C
C     UPDATE THE SMOOTHING FACTORS AS SIMULATION PROGRESSES
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/SMOOTH/XSM(2,41000),XSDMD(5,41000),XSFRQ(5,41000),
     +  BSTYP(41000)
      COMMON/ONEDMD/XDTOT,XDMIN,XDMAX,IFCNT,XDFMS,XDPRI,XDMD91(91)
      DIMENSION XFACT(2,2)
      DATA XFACT/0.8,0.2,0.9,0.1/
      IF(BSTYP(ITEM) .EQ. 0) THEN
C
C       NOT A REPLENISHMENT ITEM SO RETURN
C
        GO TO 999
      ENDIF
      X = 0.0
      DO 100 I = 1, 91
        X = X + XDMD91(I)
        IF(I .EQ. 30 .OR. I .EQ. 60) THEN
          IF(BSTYP(ITEM) .EQ. 2) THEN
            XSM(1,ITEM) = (0.9 * XSM(1,ITEM)) + (0.1 * X)
            XSM(2,ITEM) = (0.9 * XSM(2,ITEM)) + (0.1 * XSM(1,ITEM))
            X = 0.0
          ENDIF
        ENDIF
  100 CONTINUE
      XSM(1,ITEM) = (XFACT(1,BSTYP(ITEM)) * XSM(1,ITEM)) +
     +  (XFACT(2,BSTYP(ITEM)) * X)
      XSM(2,ITEM) = (XFACT(1,BSTYP(ITEM)) * XSM(2,ITEM)) +
     +  (XFACT(2,BSTYP(ITEM)) * XSM(1,ITEM))
```

```
  999 CONTINUE
      RETURN
      END
      SUBROUTINE UPDATE(IQTR,ITEM,XTDMD,IFREQ)
C
C     UPDATE THE SIMULATION GENERATED DEMAND AND FREQUENCY
C     ARRAYS FOR AN ITEM
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/SMOOTH/XSM(2,41000),XSDMD(5,41000),XSFRQ(5,41000),
     +  BSTYP(41000)
      IF(IQTR .LE. 4) THEN
        XSDMD(IQTR,ITEM) = XTDMD
        XSFRQ(IQTR,ITEM) = FLOAT(IFREQ)
      ELSE
        DO 100 I = 2, 4
          XSDMD(I-1,ITEM) = XSDMD(I,ITEM)
          XSFRQ(I-1,ITEM) = XSFRQ(I,ITEM)
  100   CONTINUE
        XSDMD(4,ITEM) = XTDMD
        XSFRQ(4,ITEM) = FLOAT(IFREQ)
      ENDIF
      XSFRQ(5,ITEM) = 0.0
      XSDMD(5,ITEM) = 0.0
      DO 200 I = 1, 4
        XSDMD(5,ITEM) = XSDMD(5,ITEM) + XSDMD(I,ITEM)
        XSFRQ(5,ITEM) = XSFRQ(5,ITEM) + XSFRQ(I,ITEM)
  200 CONTINUE
      RETURN
      END
      SUBROUTINE QFD(ITEM,XAFD,XAFDV,XFRQ)
C
C     FIGURE THE QFD FOR AN ITEM AND RETURN ANNUAL DEMAND,
C     ANNUAL DEMAND VALUE, AND ANNUAL DEMAND FREQUENCY
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      COMMON/SMOOTH/XSM(2,41000),XSDMD(5,41000),XSFRQ(5,41000),
     +  BSTYP(41000)
      COMMON/ITMDAT/JITEM(41000),XDAYS(41000),LITEM(41000),
     +  XPRICE(41000),BSTAB(2,41000),BFCODE(41000)
      XFRQ = XSFRQ(5,ITEM)
      IF(BSTYP(ITEM) .EQ. 0) THEN
C
C       NOT A REPLENISHMENT ITEM SO USE THE ACTUAL DEMAND
C       AND DEMAND VALUE
C
        XAFD = XSDMD(5,ITEM)
```

```
        XAFDV = XSDMD(5,ITEM) * XPRICE(ITEM)
        GO TO 999
      ENDIF
      XQFD = (2.0 * XSM(1,ITEM)) - XSM(2,ITEM)
      IF(BSTYP(ITEM) .EQ. 2) THEN
        XQFD = XQFD * 3.0
      ENDIF
      IF(XQFD .LT. 1.0) THEN
        XQFD = 1.0
      ENDIF
      XAFD = 4.0 * XQFD
      XAFDV = XAFD * XPRICE(ITEM)
  999 CONTINUE
      RETURN
      END
      SUBROUTINE GTSEED(DSEED)
C
C     RETURN A SEED VALUE FROM FILE 'SEED.DAT'
C
      IMPLICIT INTEGER *4 (I,K,M), INTEGER *2 (J), BYTE (B),
     +  DOUBLE PRECISION (D), CHARACTER (N), LOGICAL (L)
      OPEN(1,FILE='SEED.CNT',STATUS='OLD')
      REWIND 1
      READ(1,101) ICOUNT
  101 FORMAT(I5)
      ICOUNT = ICOUNT + 1
      IF(ICOUNT .GT. 1000) THEN
        ICOUNT = 1
      ENDIF
      REWIND 1
      WRITE(1,101) ICOUNT
      CLOSE(1)
      OPEN(1,FILE='SEED.DAT',STATUS='OLD')
      REWIND 1
      DO 100 I = 1, ICOUNT
        READ(1,*) DSEED
  100 CONTINUE
      CLOSE(1)
      PRINT *,' '
      PRINT *,'USING RANDOM NUMBER SEED # ',ICOUNT,
     +  '    VALUE = ',DSEED
      RETURN
      END
```

Appendix D

Simulation Results for Each Item Grouping

This appendix contains four sets of simulation results for each item grouping. The first set of output for each grouping contains three tables and three plots. The tables give actual versus simulated annual demand frequency, annual demand quantity, and annual demand value for each quarter of the simulation run. In each grouping, these tables are taken from the first of five simulation replications. The three plots compare totals for the same three quantities. The dual lines in each plot represent the lower and upper bounds of a 95 % confidence interval for the five simulation replications.

The second set of output for each grouping contains two tables. The first table gives the number of items in five demand frequency categories and the second table gives the number of items in each of the six demand categories. Both tables give actual versus simulated results for each quarter of the simulation run.

The third set of output contains 22 tables, two for each quarter of first simulation replication. The first of two tables for each quarter gives actual versus simulated item migration counts for migration from the categories listed in each row to the categories listed in each column. The diagonal gives the number of items remaining in the same category for a given quarter. The second table for each

quarter gives the same information but in percentage form. The values are calculated by dividing each element in the first six columns of a given row by the total in column seven. At the bottom of these tables is a measure (total squared difference) of how closely migration is being modeled. This measure is obtained by taking each element of the matrix, subtracting the actual proportion from the simulated proportion, squaring the difference, and summing all results. This quantity gives a relative measure of how well migration is being simulated for comparison across item groupings.

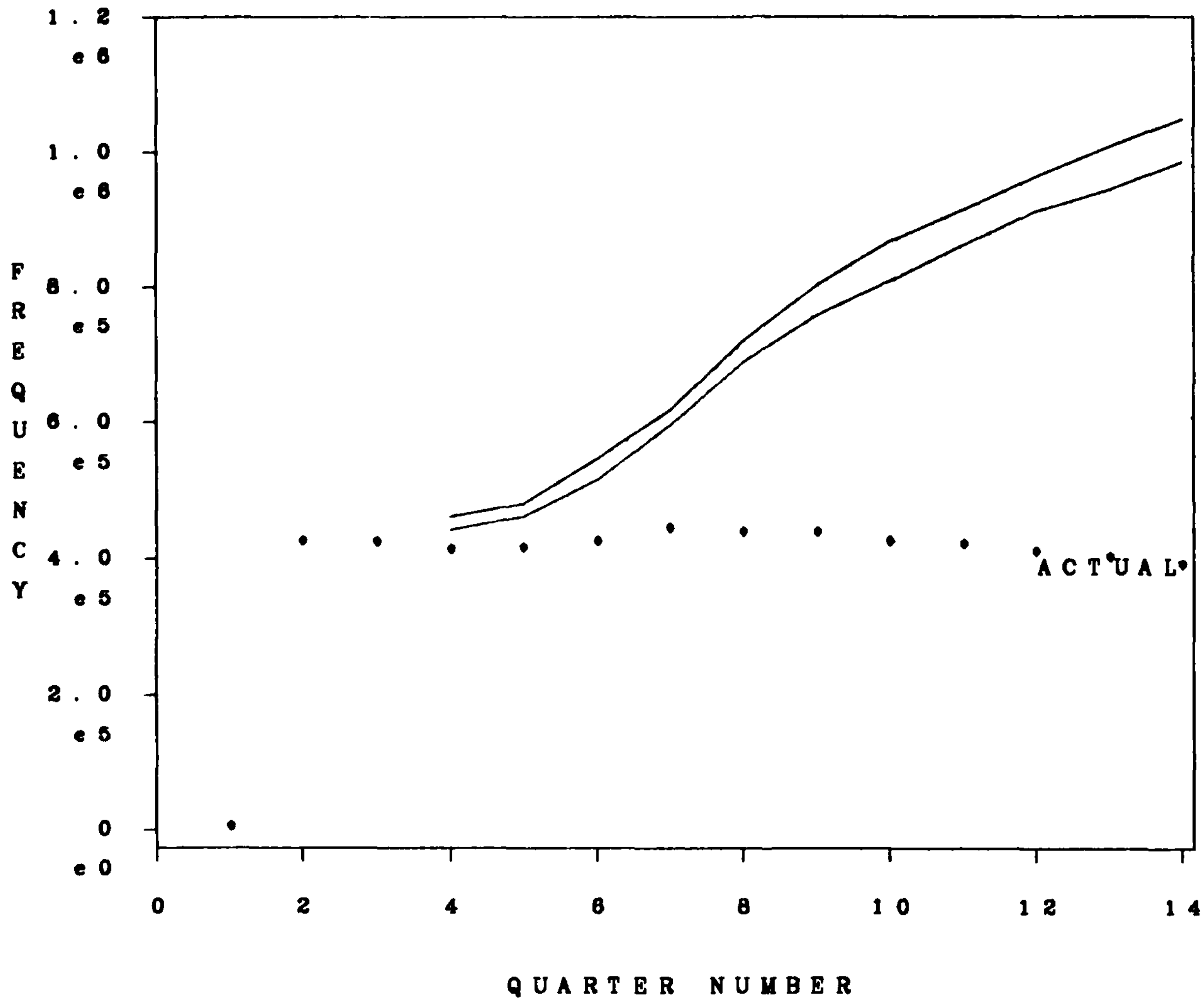
The final set of output contains two plots. The first plot gives a comparison of actual versus simulated migration volatility. Migration volatility refers to how many categories the items migrate in one quarter. For instance, migration from Non-stocked to Replenishment/High 2 represents the most volatile migration with a jump size of five categories. Migration from Non-stocked to Numeric Stockage Objective represents a jump size of one category. The plot points are the counts (total number of migrations) for each jump size from one to five. The count for items remaining in the same category is also printed. The second plot gives actual versus simulated item stability. Here the plot points are the counts of items remaining in the same demand category for a given number of quarters. For instance, the last plot point is a count of the items remaining in the same category for the entire simulation.

SIMULATION RESULTS (FIRST ITEM GROUPING)

ANNUAL DEMAND FREQUENCY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	3560	26952	35033	49290	31981	307702	454518
	ACTUAL	78	19879	25687	40235	65799	256901	408579
83-1	SIM	1614	18560	30273	44352	24152	353377	472328
	ACTUAL	523	20752	26565	40575	65603	257019	411037
83-2	SIM	1184	13629	25687	43898	23386	427093	534877
	ACTUAL	244	20916	24552	42285	65482	269867	423346
83-3	SIM	1048	10126	23785	44402	22312	501111	602784
	ACTUAL	378	21392	25299	43315	72383	277079	439846
83-4	SIM	1114	9681	22248	44743	21948	600699	700433
	ACTUAL	38	20309	26144	42729	65419	281619	436258
84-1	SIM	1214	10237	22528	45158	23979	676120	779236
	ACTUAL	843	19539	26732	44342	69344	274278	435078
84-2	SIM	1239	10862	21474	45122	24395	735910	839002
	ACTUAL	42	18831	27085	44721	70552	262244	423475
84-3	SIM	1309	11533	20735	45089	27470	793521	899657
	ACTUAL	882	18011	26894	42785	77912	249815	416299
84-4	SIM	1330	12551	19943	44765	27148	845169	950906
	ACTUAL	120	17533	24814	44282	66554	252540	405843
85-1	SIM	1246	12470	19776	45516	27714	879678	986400
	ACTUAL	1580	16593	24378	42753	63021	249382	397707
85-2	SIM	1151	12929	19376	44490	29491	910793	1018230
	ACTUAL	349	15816	23933	43458	61926	240759	386241

ANNUAL DEMAND FREQUENCY (RUN 1)



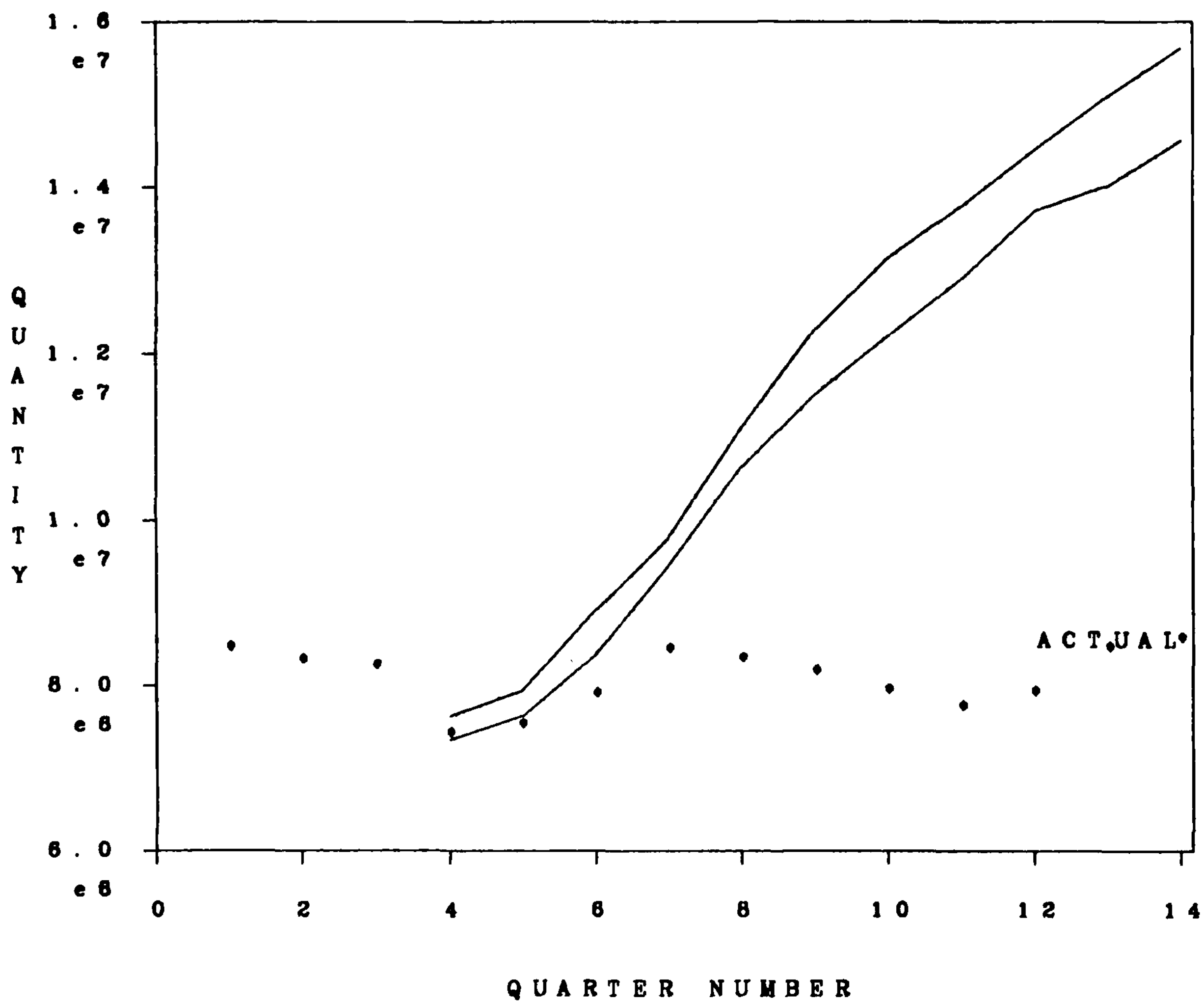
95% Confidence Band of Simulation Results

SIMULATION RESULTS (FIRST ITEM GROUPING)

ANNUAL DEMAND QUANTITY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	15951	145388	296518	677271	518114	5804534	7457776
	ACTUAL	1090	74105	254189	696862	2525225	3834572	7386043
83-1	SIM	6728	120857	284839	612463	433376	6288649	7746912
	ACTUAL	6364	75480	281169	661749	2648512	3825588	7498862
83-2	SIM	5771	92551	240455	600986	455191	7229621	8624575
	ACTUAL	3335	82093	226958	696557	2851641	4001940	7862524
83-3	SIM	5682	45647	230787	606188	463827	8066834	9418965
	ACTUAL	2228	90294	221293	695443	3408829	3998903	8416990
83-4	SIM	5417	36045	210483	610199	477335	9349418	10688897
	ACTUAL	127	83073	226318	678483	3207862	4110384	8306247
84-1	SIM	5908	38762	207203	623895	526418	10402776	11804962
	ACTUAL	8961	79011	235355	722681	3158481	3940969	8145458
84-2	SIM	5391	38839	184296	632039	558952	11202865	12622382
	ACTUAL	217	72123	258252	685591	3051590	3838691	7906464
84-3	SIM	5681	40985	174101	641566	598056	12050625	13511014
	ACTUAL	10430	60277	254606	655512	3075785	3665599	7722209
84-4	SIM	5913	47103	165580	649669	591268	12793340	14252873
	ACTUAL	603	60008	224907	682377	2997877	3930014	7895786
85-1	SIM	5509	42437	167360	645531	632594	13221124	14714555
	ACTUAL	15790	57358	227069	724197	3245093	4167927	8437434
85-2	SIM	5229	49163	160246	630691	664026	13644088	15153443
	ACTUAL	846	55751	231333	701261	3293255	4268149	8550595

ANNUAL DEMAND QUANTITY (RUN 1)



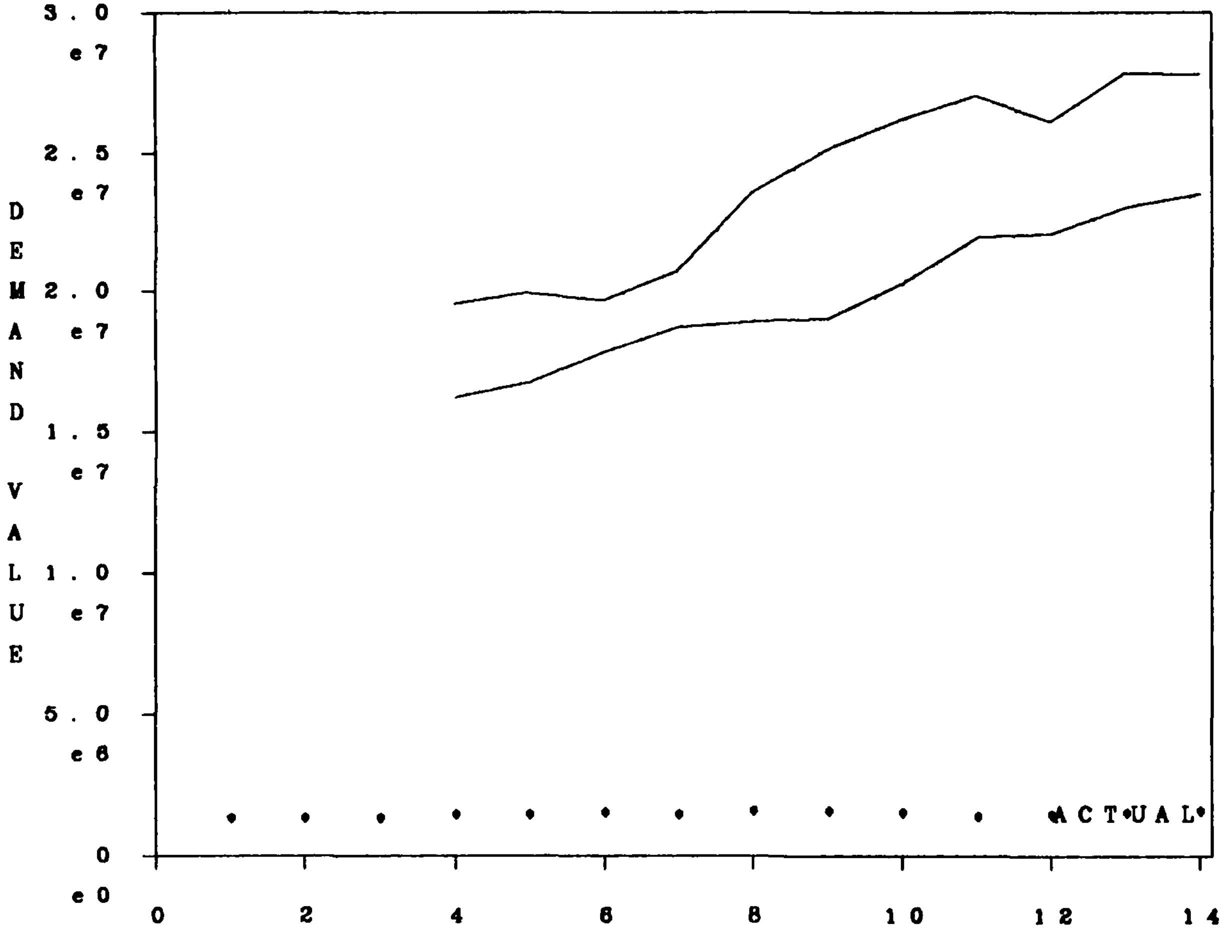
95% Confidence Band of Simulation Results

SIMULATION RESULTS (FIRST ITEM GROUPING)

ANNUAL DEMAND VALUE BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	539504	3201532	646384	5929078	10312293	1537124864	1557753600
	ACTUAL	7226	3865751	667380	3365566	8748398	114670864	131325184
83-1	SIM	117457	1867472	522918	4982697	6963079	1637253504	1651707136
	ACTUAL	113649	4061098	673067	3653195	8440463	113786432	130727910
83-2	SIM	59699	1439271	438357	4515759	5493653	1757974784	1769921536
	ACTUAL	34012	4509959	663035	3521649	8125791	116912320	133766768
83-3	SIM	48804	1167125	405595	4252861	5067943	1885863296	1896805632
	ACTUAL	47756	4685676	602095	3238073	8936554	112067296	129577456
83-4	SIM	66498	1138950	375031	4170210	4747985	2043834240	2054332928
	ACTUAL	4406	4173377	628858	3906527	8664319	122958128	140335616
84-1	SIM	560145	1248098	385104	4017915	5206943	2090115840	2101534080
	ACTUAL	117438	3856301	651863	3975632	9737451	121541248	139879936
84-2	SIM	572526	1241215	348721	3904601	5001382	2196019200	2207087616
	ACTUAL	3071	3783336	600674	3929928	10564282	117688640	136569936
84-3	SIM	588179	1381985	336358	3890081	5337586	2227680768	2239214848
	ACTUAL	113723	3324610	563628	3656849	11293825	101913840	120866480
84-4	SIM	580793	2238198	310169	3966463	4852112	2271376896	2283324672
	ACTUAL	7840	3623736	580906	4197255	10061051	113911288	132382080
85-1	SIM	82591	1858879	318577	3877983	5067970	2710161408	2721367296
	ACTUAL	205523	3540096	624354	4164228	9832823	117296720	135663744
85-2	SIM	65696	3715334	316018	3746489	5121758	2731660288	2744625664
	ACTUAL	166702	3252831	626310	4241083	10345486	125191104	143823520

ANNUAL DEMAND VALUE (RUN 1)



QUARTER NUMBER
(Simulated versus Actual)/100

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND FREQUENCY GROUP ITEM COUNTS

QUARTER	SOURCE	0	1-9	10-19	20-199	200-UP
82-4	SIMULATED	22080	12647	2099	3750	333
	ACTUAL	24361	12980	1290	1829	449
	% DIFFERENCE	-9.36	-2.57	62.71	105.03	-25.84
83-1	SIMULATED	26353	8539	1853	3834	330
	ACTUAL	23203	14096	1312	1841	457
	% DIFFERENCE	13.58	-39.42	41.23	108.26	-27.79
83-2	SIMULATED	28105	6621	1531	4275	377
	ACTUAL	23361	13866	1337	1880	465
	% DIFFERENCE	20.31	-52.25	14.51	127.39	-18.92
83-3	SIMULATED	28703	5786	1362	4560	498
	ACTUAL	22754	14375	1374	1925	481
	% DIFFERENCE	26.14	-59.75	-0.87	136.88	3.53
83-4	SIMULATED	28853	5438	1265	4661	692
	ACTUAL	23577	13581	1341	1929	481
	% DIFFERENCE	22.38	-59.96	-5.67	141.63	43.87
84-1	SIMULATED	28432	5685	1193	4769	830
	ACTUAL	23668	13452	1370	1933	486
	% DIFFERENCE	20.13	-57.74	-12.92	146.71	70.78
84-2	SIMULATED	27919	6046	1112	4906	926
	ACTUAL	24465	12703	1362	1909	470
	% DIFFERENCE	14.12	-52.40	-18.36	156.99	97.02
84-3	SIMULATED	27378	6499	1040	5015	977
	ACTUAL	24548	12596	1398	1897	470
	% DIFFERENCE	11.53	-48.40	-25.61	164.36	107.87
84-4	SIMULATED	26930	6819	1045	5090	1025
	ACTUAL	25093	12076	1403	1875	462
	% DIFFERENCE	7.32	-43.53	-25.52	171.47	121.86
85-1	SIMULATED	26724	6914	962	5226	1083
	ACTUAL	25060	12145	1380	1869	455
	% DIFFERENCE	6.64	-43.07	-30.29	179.61	138.02
85-2	SIMULATED	26464	6996	1006	5289	1154
	ACTUAL	25664	11564	1380	1865	436
	% DIFFERENCE	3.12	-39.50	-27.10	183.59	164.68

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY ITEM COUNT SUMMARY

QUARTER		N-S	NSO	R/L	R/M	R/H1	R/H2
82-4	SIMULATED	4571	27006	3231	2859	902	2340
	ACTUAL	9259	24281	3338	1862	724	1445
83-1	SIMULATED	4497	26922	3274	2766	779	2671
	ACTUAL	7549	25791	3536	1847	685	1501
83-2	SIMULATED	4436	26891	3196	2672	693	3021
	ACTUAL	8510	24740	3548	1862	668	1581
83-3	SIMULATED	4377	26779	3175	2580	654	3344
	ACTUAL	8833	24369	3496	1870	741	1600
83-4	SIMULATED	4319	28729	1895	1880	512	3574
	ACTUAL	9292	23884	3552	1871	702	1608
84-1	SIMULATED	4243	28687	1852	1820	523	3784
	ACTUAL	9624	23204	3864	1931	764	1522
84-2	SIMULATED	4166	28625	1817	1800	514	3987
	ACTUAL	9805	23360	3567	1957	794	1426
84-3	SIMULATED	4099	28558	1791	1767	531	4163
	ACTUAL	9810	23316	3567	2012	907	1297
84-4	SIMULATED	4047	28498	1741	1768	521	4334
	ACTUAL	10940	22261	3503	2057	783	1365
85-1	SIMULATED	4002	28390	1728	1773	501	4515
	ACTUAL	10945	21959	3724	2123	784	1374
85-2	SIMULATED	3951	28279	1715	1753	533	4678
	ACTUAL	11085	21605	3934	2165	785	1335

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4571	0	598	501	108	50	5828
ACTUAL		6190	38	9	4	3	0	6244
SIMULATED	NSO	0	26108	1323	876	174	50	28531
ACTUAL		2932	23890	269	140	19	16	27266
SIMULATED	R/L	0	710	1230	978	149	47	3114
ACTUAL		105	279	2827	140	1	1	3353
SIMULATED	R/M	0	155	71	440	368	620	1654
ACTUAL		27	63	232	1499	93	12	1926
SIMULATED	R/H1	0	21	4	44	44	601	714
ACTUAL		5	8	1	77	560	184	835
SIMULATED	R/H2	0	12	5	20	59	972	1068
ACTUAL		0	3	0	2	48	1232	1285

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	78.4317	0.0000	10.2608	8.5964	1.8531	0.8579
ACTUAL		99.1352	0.6086	0.1441	0.0641	0.0480	0.0000
SIMULATED	NSO	0.0000	91.5075	4.6371	3.0703	0.6099	0.1752
ACTUAL		10.7533	87.6183	0.9866	0.5135	0.0697	0.0587
SIMULATED	R/L	0.0000	22.8003	39.4990	31.4066	4.7848	1.5093
ACTUAL		3.1315	8.3209	84.3126	4.1754	0.0298	0.0298
SIMULATED	R/M	0.0000	9.3712	4.2926	26.6022	22.2491	37.4849
ACTUAL		1.4019	3.2710	12.0457	77.8297	4.8287	0.6231
SIMULATED	R/H1	0.0000	2.9412	0.5602	6.1625	6.1625	84.1737
ACTUAL		0.5988	0.9581	0.1198	9.2216	67.0659	22.0359
SIMULATED	R/H2	0.0000	1.1236	0.4682	1.8727	5.5243	91.0112
ACTUAL		0.0000	0.2335	0.0000	0.1556	3.7354	95.8755

TOTAL SQUARED DIFFERENCE = 1.575392

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4497	0	38	30	4	2	4571
ACTUAL		6237	2845	133	32	9	3	9259
SIMULATED	NSO	0	26721	164	95	20	6	27006
ACTUAL		1259	22546	295	143	24	14	24281
SIMULATED	R/L	0	135	2858	231	6	1	3231
ACTUAL		21	325	2847	144	1	0	3338
SIMULATED	R/M	0	55	214	2284	238	68	2859
ACTUAL		16	68	259	1442	72	5	1862
SIMULATED	R/H1	0	8	0	126	455	313	902
ACTUAL		5	7	2	83	497	130	724
SIMULATED	R/H2	0	3	0	0	56	2281	2340
ACTUAL		11	0	0	3	82	1349	1445

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.3811	0.0000	0.8313	0.6563	0.0875	0.0438
ACTUAL		67.3615	30.7269	1.4364	0.3456	0.0972	0.0324
SIMULATED	NSO	0.0000	98.9447	0.6073	0.3518	0.0741	0.0222
ACTUAL		5.1851	92.8545	1.2149	0.5889	0.0988	0.0577
SIMULATED	R/L	0.0000	4.1783	88.4556	7.1495	0.1857	0.0310
ACTUAL		0.6291	9.7364	85.2906	4.3140	0.0300	0.0000
SIMULATED	R/M	0.0000	1.9237	7.4851	79.8881	8.3246	2.3785
ACTUAL		0.8593	3.6520	13.9098	77.4436	3.8668	0.2685
SIMULATED	R/H1	0.0000	0.8869	0.0000	13.9690	50.4435	34.7007
ACTUAL		0.6906	0.9669	0.2762	11.4641	68.6464	17.9558
SIMULATED	R/H2	0.0000	0.1282	0.0000	0.0000	2.3932	97.4786
ACTUAL		0.7612	0.0000	0.0000	0.2076	5.6747	93.3564

TOTAL SQUARED DIFFERENCE = 0.274287

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4436	0	41	18	2	0	4497
ACTUAL		7376	115	23	11	4	20	7549
SIMULATED	NSO	0	26662	143	93	14	10	26922
ACTUAL		1110	24225	280	136	24	16	25791
SIMULATED	R/L	0	144	2889	234	4	3	3274
ACTUAL		16	326	3024	166	0	4	3536
SIMULATED	R/M	0	69	122	2271	241	63	2766
ACTUAL		6	61	220	1462	90	8	1847
SIMULATED	R/H1	0	12	1	56	396	314	779
ACTUAL		2	7	1	87	476	112	685
SIMULATED	R/H2	0	4	0	0	36	2631	2671
ACTUAL		0	6	0	0	74	1421	1501

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.6435	0.0000	0.9117	0.4003	0.0445	0.0000
ACTUAL		97.7083	1.5234	0.3047	0.1457	0.0530	0.2649
SIMULATED	NSO	0.0000	99.0342	0.5312	0.3454	0.0520	0.0371
ACTUAL		4.3038	93.9281	1.0856	0.5273	0.0931	0.0620
SIMULATED	R/L	0.0000	4.3983	88.2407	7.1472	0.1222	0.0916
ACTUAL		0.4525	9.2195	85.5204	4.6946	0.0000	0.1131
SIMULATED	R/M	0.0000	2.4946	4.4107	82.1041	8.7129	2.2777
ACTUAL		0.3249	3.3027	11.9112	79.1554	4.8728	0.4331
SIMULATED	R/H1	0.0000	1.5404	0.1284	7.1887	50.8344	40.3081
ACTUAL		0.2920	1.0219	0.1460	12.7007	69.4890	16.3504
SIMULATED	R/H2	0.0000	0.1498	0.0000	0.0000	1.3478	98.5024
ACTUAL		0.0000	0.3997	0.0000	0.0000	4.9300	94.6702

TOTAL SQUARED DIFFERENCE = 0.114966

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4377	0	41	10	6	2	4436
ACTUAL		8312	170	8	7	5	8	8510
SIMULATED	NSO	0	26624	151	91	20	5	26891
ACTUAL		508	23766	269	155	28	14	24740
SIMULATED	R/L	0	108	2860	220	7	1	3196
ACTUAL		13	353	2936	236	6	4	3548
SIMULATED	R/M	0	39	123	2230	204	76	2672
ACTUAL		0	67	281	1393	110	11	1862
SIMULATED	R/H1	0	5	0	29	394	265	693
ACTUAL		0	10	1	77	453	127	668
SIMULATED	R/H2	0	3	0	0	23	2995	3021
ACTUAL		0	3	1	2	139	1436	1581

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.6700	0.0000	0.9243	0.2254	0.1353	0.0451
ACTUAL		97.6733	1.9976	0.0940	0.0823	0.0588	0.0940
SIMULATED	NSO	0.0000	99.0071	0.5615	0.3384	0.0744	0.0186
ACTUAL		2.0534	96.0631	1.0873	0.6265	0.1132	0.0566
SIMULATED	R/L	0.0000	3.3792	89.4869	6.8836	0.2190	0.0313
ACTUAL		0.3664	9.9493	82.7508	6.6516	0.1691	0.1127
SIMULATED	R/M	0.0000	1.4596	4.6033	83.4581	7.6347	2.8443
ACTUAL		0.0000	3.5983	15.0913	74.8120	5.9076	0.5908
SIMULATED	R/H1	0.0000	0.7215	0.0000	4.1847	56.8543	38.2395
ACTUAL		0.0000	1.4970	0.1497	11.5269	67.8144	19.0120
SIMULATED	R/H2	0.0000	0.0993	0.0000	0.0000	0.7613	99.1394
ACTUAL		0.0000	0.1898	0.0633	0.1265	8.7919	90.8286

TOTAL SQUARED DIFFERENCE = 0.098302

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4319	0	29	22	4	3	4377
ACTUAL		8692	130	8	2	1	0	8833
SIMULATED	NSO	0	26508	162	86	17	6	26779
ACTUAL		554	23398	274	113	23	7	24369
SIMULATED	R/L	0	1364	1604	198	9	0	3175
ACTUAL		28	298	3006	162	2	0	3496
SIMULATED	R/M	0	702	100	1540	186	52	2580
ACTUAL		12	50	263	1482	63	0	1870
SIMULATED	R/H1	0	118	0	34	272	230	654
ACTUAL		3	7	0	107	518	106	741
SIMULATED	R/H2	0	37	0	0	24	3283	3344
ACTUAL		3	1	1	5	95	1495	1600

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.6749	0.0000	0.6626	0.5026	0.0914	0.0685
ACTUAL		98.4037	1.4718	0.0906	0.0226	0.0113	0.0000
SIMULATED	NSO	0.0000	98.9880	0.6050	0.3211	0.0635	0.0224
ACTUAL		2.2734	96.0154	1.1244	0.4637	0.0944	0.0287
SIMULATED	R/L	0.0000	42.9606	50.5197	6.2362	0.2835	0.0000
ACTUAL		0.8009	8.5240	85.9840	4.6339	0.0572	0.0000
SIMULATED	R/M	0.0000	27.2093	3.8760	59.6899	7.2093	2.0155
ACTUAL		0.6417	2.6738	14.0642	79.2513	3.3690	0.0000
SIMULATED	R/H1	0.0000	18.0428	0.0000	5.1988	41.5902	35.1682
ACTUAL		0.4049	0.9447	0.0000	14.4399	69.9055	14.3050
SIMULATED	R/H2	0.0000	1.1065	0.0000	0.0000	0.7177	98.1758
ACTUAL		0.1875	0.0625	0.0625	0.3125	5.9375	93.4375

TOTAL SQUARED DIFFERENCE = 0.523749

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4243	0	43	28	3	2	4319
ACTUAL		9136	143	9	4	0	0	9292
SIMULATED	NSO	0	28409	194	106	14	6	28729
ACTUAL		448	23010	267	128	26	5	23884
SIMULATED	R/L	0	218	1507	163	7	0	1895
ACTUAL		21	25	3352	154	0	0	3552
SIMULATED	R/M	0	56	108	1492	184	40	1880
ACTUAL		8	20	235	1528	78	2	1871
SIMULATED	R/H1	0	3	0	31	277	201	512
ACTUAL		4	4	1	114	521	58	702
SIMULATED	R/H2	0	1	0	0	38	3535	3574
ACTUAL		7	2	0	3	139	1457	1608

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.2403	0.0000	0.9956	0.6483	0.0695	0.0463
ACTUAL		98.3211	1.5390	0.0969	0.0430	0.0000	0.0000
SIMULATED	NSO	0.0000	98.8861	0.6753	0.3690	0.0487	0.0209
ACTUAL		1.8757	96.3406	1.1179	0.5359	0.1089	0.0209
SIMULATED	R/L	0.0000	11.5040	79.5251	8.6016	0.3694	0.0000
ACTUAL		0.5912	0.7038	94.3694	4.3356	0.0000	0.0000
SIMULATED	R/M	0.0000	2.9787	5.7447	79.3617	9.7872	2.1277
ACTUAL		0.4276	1.0689	12.5601	81.6676	4.1689	0.1069
SIMULATED	R/H1	0.0000	0.5859	0.0000	6.0547	54.1016	39.2578
ACTUAL		0.5698	0.5698	0.1425	16.2393	74.2165	8.2621
SIMULATED	R/H2	0.0000	0.0280	0.0000	0.0000	1.0632	98.9088
ACTUAL		0.4353	0.1244	0.0000	0.1866	8.6443	90.6095

TOTAL SQUARED DIFFERENCE = 0.205671

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4166	0	45	24	8	0	4243
ACTUAL		8587	1012	20	4	0	1	9624
SIMULATED	NSO	0	28375	195	89	21	7	28687
ACTUAL		1171	21671	217	117	22	6	23204
SIMULATED	R/L	0	195	1483	168	3	3	1852
ACTUAL		30	557	3100	174	3	0	3864
SIMULATED	R/M	0	51	94	1490	159	26	1820
ACTUAL		8	102	229	1526	63	3	1931
SIMULATED	R/H1	0	1	0	29	284	209	523
ACTUAL		2	12	1	131	552	66	764
SIMULATED	R/H2	0	3	0	0	39	3742	3784
ACTUAL		7	6	0	5	154	1350	1522

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.1852	0.0000	1.0606	0.5656	0.1885	0.0000
ACTUAL		89.2249	10.5154	0.2078	0.0416	0.0000	0.0104
SIMULATED	NSO	0.0000	98.9124	0.6798	0.3102	0.0732	0.0244
ACTUAL		5.0465	93.3934	0.9352	0.5042	0.0948	0.0259
SIMULATED	R/L	0.0000	10.5292	80.0756	9.0713	0.1620	0.1620
ACTUAL		0.7764	14.4151	80.2277	4.5031	0.0776	0.0000
SIMULATED	R/M	0.0000	2.8022	5.1648	81.8681	8.7363	1.4286
ACTUAL		0.4143	5.2822	11.8591	79.0264	3.2626	0.1554
SIMULATED	R/H1	0.0000	0.1912	0.0000	5.5449	54.3021	39.9618
ACTUAL		0.2618	1.5707	0.1309	17.1466	72.2513	8.6387
SIMULATED	R/H2	0.0000	0.0793	0.0000	0.0000	1.0307	98.8901
ACTUAL		0.4599	0.3942	0.0000	0.3285	10.1183	88.6991

TOTAL SQUARED DIFFERENCE = 0.200210

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4099	0	34	29	3	1	4166
ACTUAL		9659	136	7	1	1	1	9805
SIMULATED	NSO	0	28309	187	103	22	4	28625
ACTUAL		109	22822	249	148	24	8	23360
SIMULATED	R/L	0	192	1466	154	4	1	1817
ACTUAL		19	275	3049	221	3	0	3567
SIMULATED	R/M	0	50	104	1451	152	43	1800
ACTUAL		10	72	258	1500	105	12	1957
SIMULATED	R/H1	0	6	0	30	307	171	514
ACTUAL		5	9	3	133	564	80	794
SIMULATED	R/H2	0	1	0	0	43	3943	3987
ACTUAL		8	2	1	9	210	1196	1426

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.3917	0.0000	0.8161	0.6961	0.0720	0.0240
ACTUAL		98.5110	1.3870	0.0714	0.0102	0.0102	0.0102
SIMULATED	NSO	0.0000	98.8961	0.6533	0.3598	0.0769	0.0140
ACTUAL		0.4666	97.6969	1.0659	0.6336	0.1027	0.0342
SIMULATED	R/L	0.0000	10.5669	80.6824	8.4755	0.2201	0.0550
ACTUAL		0.5327	7.7096	85.4780	6.1957	0.0841	0.0000
SIMULATED	R/M	0.0000	2.7778	5.7778	80.6111	8.4444	2.3889
ACTUAL		0.5110	3.6791	13.1834	76.6479	5.3654	0.6132
SIMULATED	R/H1	0.0000	1.1673	0.0000	5.8366	59.7276	33.2685
ACTUAL		0.6297	1.1335	0.3778	16.7506	71.0327	10.0756
SIMULATED	R/H2	0.0000	0.0251	0.0000	0.0000	1.0785	98.8964
ACTUAL		0.5610	0.1403	0.0701	0.6311	14.7265	83.8710

TOTAL SQUARED DIFFERENCE = 0.132393

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4047	0	27	22	2	1	4099
ACTUAL		9773	34	2	1	0	0	9810
SIMULATED	NSO	0	28218	198	120	20	2	28558
ACTUAL		1124	21805	224	142	13	8	23316
SIMULATED	R/L	0	208	1438	138	6	1	1791
ACTUAL		24	313	3055	174	1	0	3567
SIMULATED	R/M	0	62	78	1464	131	32	1767
ACTUAL		11	83	219	1617	72	10	2012
SIMULATED	R/H1	0	8	0	24	325	174	531
ACTUAL		2	19	3	120	621	142	907
SIMULATED	R/H2	0	2	0	0	37	4124	4163
ACTUAL		6	7	0	3	76	1205	1297

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.7314	0.0000	0.6587	0.5367	0.0488	0.0244
ACTUAL		99.6228	0.3466	0.0204	0.0102	0.0000	0.0000
SIMULATED	NSO	0.0000	98.8094	0.6933	0.4202	0.0700	0.0070
ACTUAL		4.8207	93.5195	0.9607	0.6090	0.0558	0.0343
SIMULATED	R/L	0.0000	11.6136	80.2903	7.7052	0.3350	0.0558
ACTUAL		0.6728	8.7749	85.6462	4.8780	0.0280	0.0000
SIMULATED	R/M	0.0000	3.5088	4.4143	82.8523	7.4137	1.8110
ACTUAL		0.5467	4.1252	10.8847	80.3678	3.5785	0.4970
SIMULATED	R/H1	0.0000	1.5066	0.0000	4.5198	61.2053	32.7684
ACTUAL		0.2205	2.0948	0.3308	13.2304	68.4675	15.6560
SIMULATED	R/H2	0.0000	0.0480	0.0000	0.0000	0.8888	99.0632
ACTUAL		0.4626	0.5397	0.0000	0.2313	5.8597	92.9067

TOTAL SQUARED DIFFERENCE = 0.064845

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4002	0	28	12	4	1	4047
ACTUAL		10781	136	14	6	3	0	10940
SIMULATED	NSO	0	28107	227	136	12	16	28498
ACTUAL		114	21786	210	133	15	3	22261
SIMULATED	R/L	0	208	1391	135	5	2	1741
ACTUAL		25	18	3262	196	2	0	3503
SIMULATED	R/M	0	65	82	1456	125	40	1768
ACTUAL		13	16	236	1677	110	5	2057
SIMULATED	R/H1	0	9	0	34	311	167	521
ACTUAL		3	1	1	108	539	131	783
SIMULATED	R/H2	0	1	0	0	44	4289	4334
ACTUAL		9	2	1	3	115	1235	1365

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.8881	0.0000	0.6919	0.2965	0.0988	0.0247
ACTUAL		98.5466	1.2431	0.1280	0.0548	0.0274	0.0000
SIMULATED	NSO	0.0000	98.6280	0.7965	0.4772	0.0421	0.0561
ACTUAL		0.5121	97.8662	0.9434	0.5975	0.0674	0.0135
SIMULATED	R/L	0.0000	11.9472	79.8966	7.7542	0.2872	0.1149
ACTUAL		0.7137	0.5138	93.1202	5.5952	0.0571	0.0000
SIMULATED	R/M	0.0000	3.6765	4.6380	82.3529	7.0701	2.2624
ACTUAL		0.6320	0.7778	11.4730	81.5265	5.3476	0.2431
SIMULATED	R/H1	0.0000	1.7274	0.0000	6.5259	59.6929	32.0537
ACTUAL		0.3831	0.1277	0.1277	13.7931	68.8378	16.7305
SIMULATED	R/H2	0.0000	0.0231	0.0000	0.0000	1.0152	98.9617
ACTUAL		0.6593	0.1465	0.0733	0.2198	8.4249	90.4762

TOTAL SQUARED DIFFERENCE = 0.087837

SIMULATION RESULTS (FIRST ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2

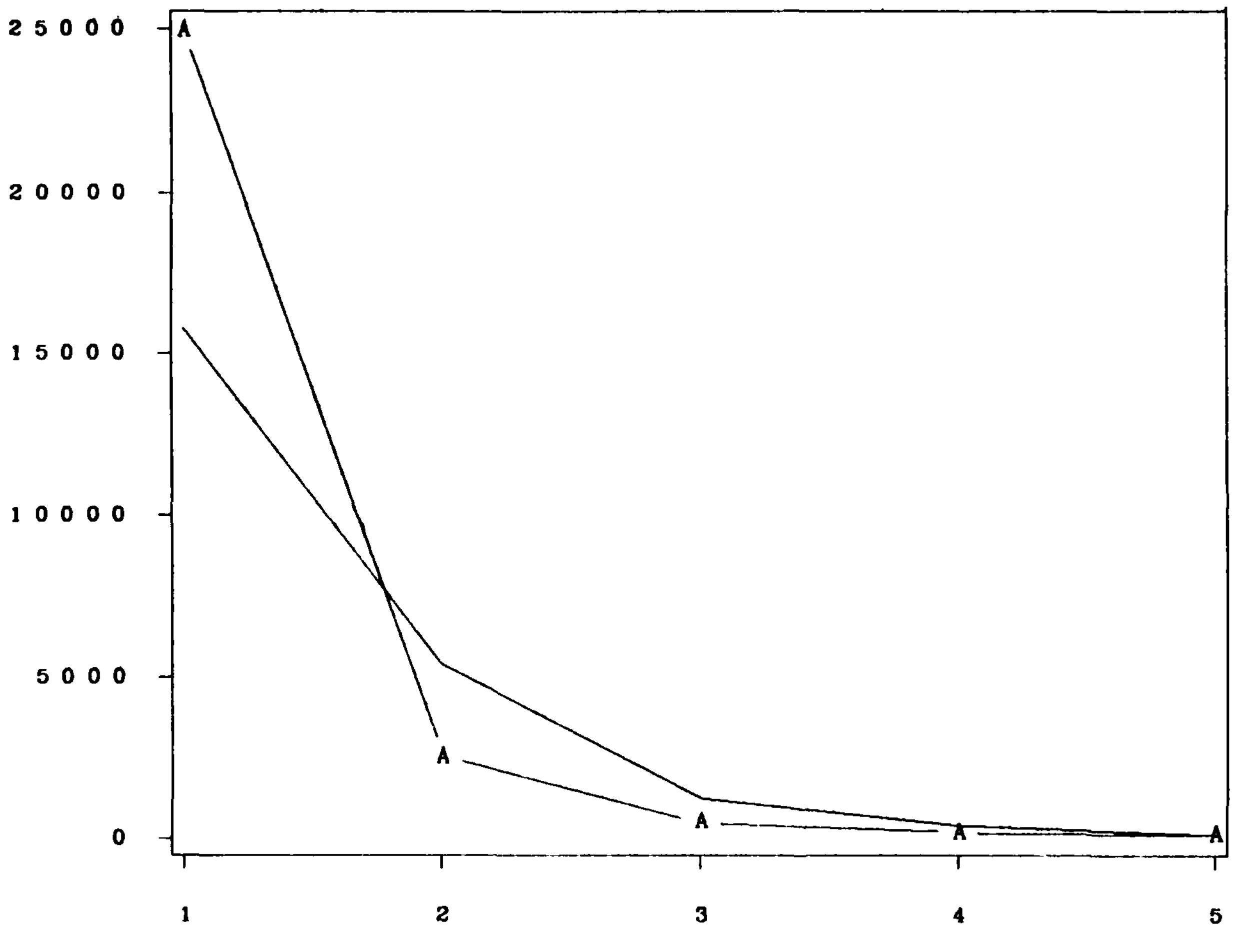
	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	3951	0	30	19	1	1	4002
ACTUAL		10747	182	11	2	1	2	10945
SIMULATED	NSO	0	28026	214	126	18	6	28390
ACTUAL		271	21363	175	121	24	5	21959
SIMULATED	R/L	0	192	1387	146	2	1	1728
ACTUAL		41	31	3486	165	1	0	3724
SIMULATED	R/M	0	51	84	1442	157	39	1773
ACTUAL		14	26	261	1735	80	7	2123
SIMULATED	R/H1	0	7	0	20	309	165	501
ACTUAL		4	2	1	139	553	85	784
SIMULATED	R/H2	0	3	0	0	46	4466	4515
ACTUAL		8	1	0	3	126	1236	1374

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.7256	0.0000	0.7496	0.4748	0.0250	0.0250
ACTUAL		98.1910	1.6629	0.1005	0.0183	0.0091	0.0183
SIMULATED	NSO	0.0000	98.7179	0.7538	0.4438	0.0634	0.0211
ACTUAL		1.2341	97.2858	0.7969	0.5510	0.1093	0.0228
SIMULATED	R/L	0.0000	11.1111	80.2662	8.4491	0.1157	0.0579
ACTUAL		1.1010	0.8324	93.6090	4.4307	0.0269	0.0000
SIMULATED	R/M	0.0000	2.8765	4.7377	81.3311	8.8550	2.1997
ACTUAL		0.6594	1.2247	12.2939	81.7240	3.7683	0.3297
SIMULATED	R/H1	0.0000	1.3972	0.0000	3.9920	61.6766	32.9341
ACTUAL		0.5102	0.2551	0.1276	17.7296	70.5357	10.8418
SIMULATED	R/H2	0.0000	0.0664	0.0000	0.0000	1.0188	98.9147
ACTUAL		0.5822	0.0728	0.0000	0.2183	9.1703	89.9563

TOTAL SQUARED DIFFERENCE = 0.130205

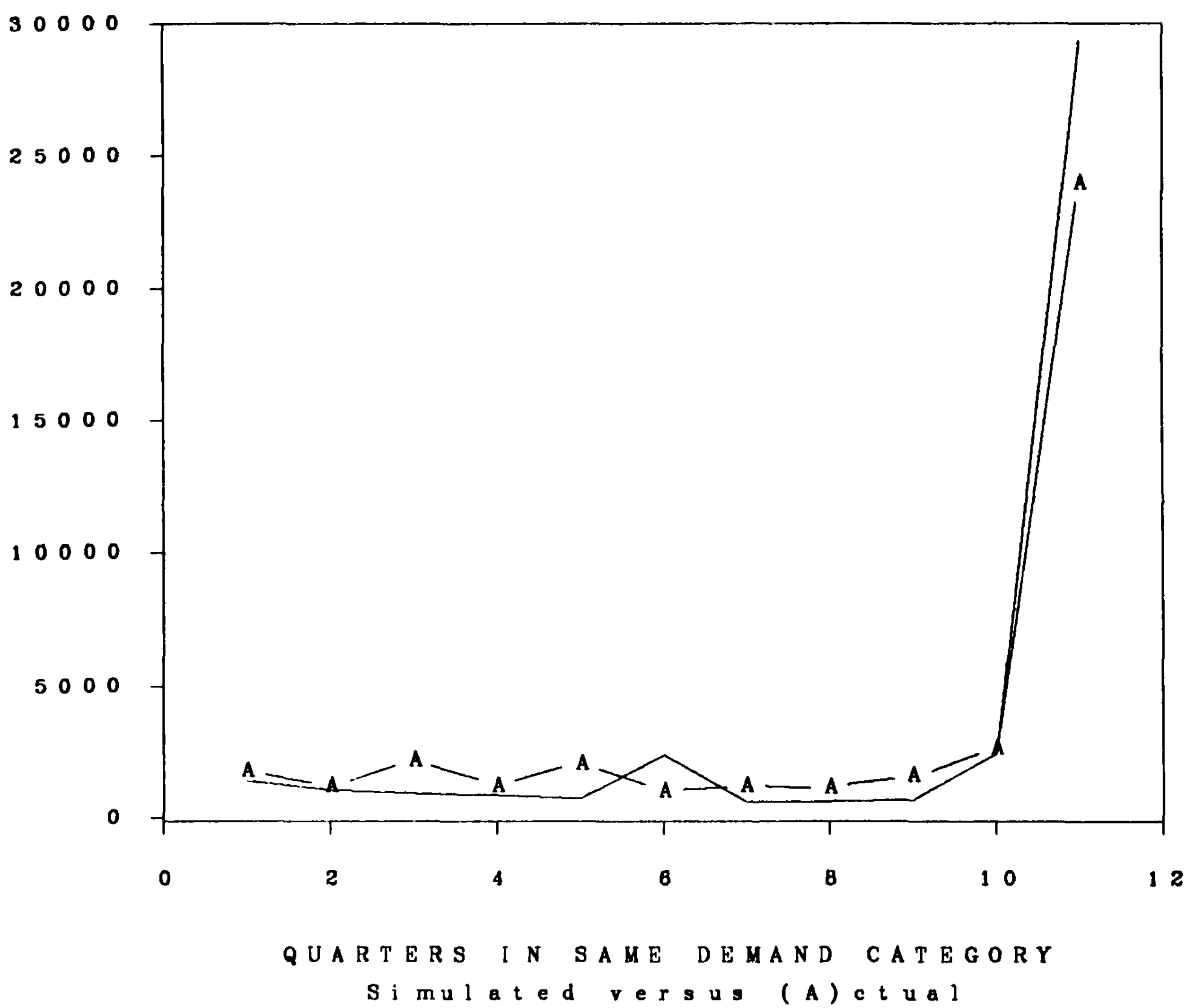
DEMAND CATEGORY MIGRATION JUMP SIZE (RUN 1)



SIZE OF JUMP

Simulated versus (A)ctual

DEMAND CATEGORY STABILITY (RUN 1)

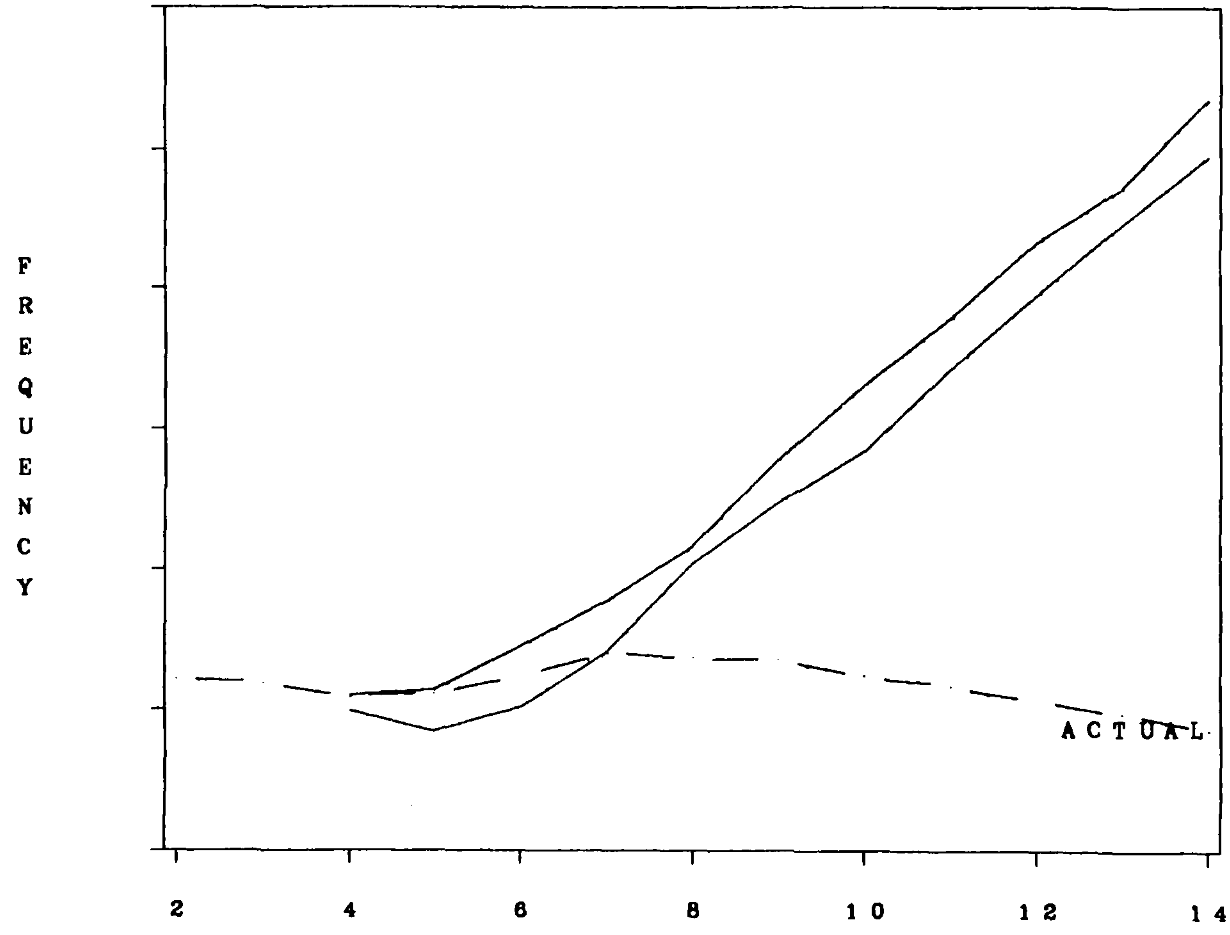


SIMULATION RESULTS (SECOND ITEM GROUPING)

ANNUAL DEMAND FREQUENCY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	3593	24194	38564	56544	40426	241655	404976
	ACTUAL	78	19879	25687	40235	65799	256901	408579
83-1	SIM	2051	17933	33868	58779	39840	247134	399605
	ACTUAL	523	20752	26565	40575	65603	257019	411037
83-2	SIM	1743	18915	31138	62874	37261	260285	412216
	ACTUAL	244	20916	24552	42285	65482	269867	423346
83-3	SIM	1607	17456	30570	65941	38358	292664	446596
	ACTUAL	378	21392	25299	43315	72383	277079	439846
83-4	SIM	1485	16864	28761	71771	39590	347093	505564
	ACTUAL	38	20309	26144	42729	65419	281619	436258
84-1	SIM	1337	16763	27809	73896	43114	405529	568448
	ACTUAL	843	19539	26732	44342	69344	274278	435078
84-2	SIM	1283	15656	26684	76681	42929	452463	615696
	ACTUAL	42	18831	27085	44721	70552	262244	423475
84-3	SIM	1260	15866	25163	77800	44301	514070	678460
	ACTUAL	882	18011	26894	42785	77912	249815	416299
84-4	SIM	1205	15785	23819	78063	43605	551737	714214
	ACTUAL	120	17533	24814	44282	66554	252540	405843
85-1	SIM	1133	15028	23355	77646	45988	585993	749143
	ACTUAL	1580	16593	24378	42753	63021	249382	397707
85-2	SIM	1012	15296	22346	78875	46669	650164	814362
	ACTUAL	349	15816	23933	43458	61926	240759	386241

ANNUAL DEMAND FREQUENCY (RUN 2)



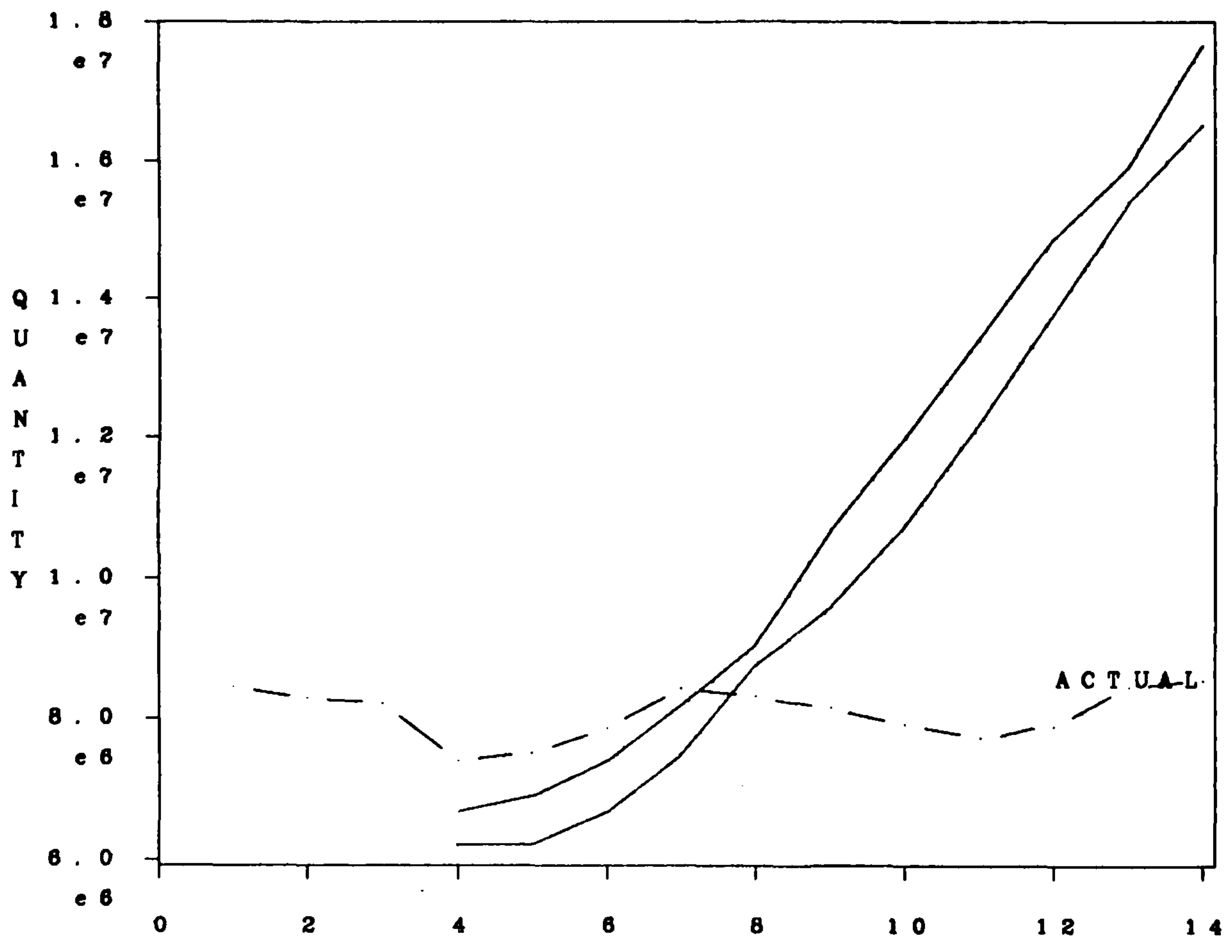
95% Confidence Band of Simulation Results

SIMULATION RESULTS (SECOND ITEM GROUPING)

ANNUAL DEMAND QUANTITY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	17075	109993	418456	776988	797489	4364415	6484416
	ACTUAL	1090	74105	254189	696862	2525225	3834572	7386043
83-1	SIM	9421	72433	368090	803932	807542	4399303	6460721
	ACTUAL	6364	75480	281169	661749	2648512	3825588	7498862
83-2	SIM	7892	119577	314180	879681	715358	4827687	6864375
	ACTUAL	3335	82093	226958	696557	2851641	4001940	7862524
83-3	SIM	7537	107031	293857	911766	719199	5590013	7629403
	ACTUAL	2228	90294	221293	695443	3408829	3998903	8416990
83-4	SIM	6645	102752	257738	1011048	661475	6822740	8862398
	ACTUAL	127	83073	226318	678483	3207862	4110384	8306247
84-1	SIM	6576	102753	234695	1005758	755327	8259283	10364392
	ACTUAL	8961	79011	235355	722681	3158481	3940969	8145458
84-2	SIM	7632	49088	227554	1048853	741115	9581389	11655631
	ACTUAL	217	72123	258252	685591	3051590	3838691	7906464
84-3	SIM	8158	55659	216863	1057746	748726	11251403	13338555
	ACTUAL	10430	60277	254606	655512	3075785	3665599	7722209
84-4	SIM	9050	58213	208558	1068932	654166	12547100	14546019
	ACTUAL	603	60008	224907	682377	2997877	3930014	7895786
85-1	SIM	8733	49426	213249	1053504	683728	13643137	15651777
	ACTUAL	15790	57358	227069	724197	3245093	4167927	8437434
85-2	SIM	7551	55816	193602	1063568	760244	15102202	17182984
	ACTUAL	846	55751	231333	701261	3293255	4268149	8550595

ANNUAL DEMAND QUANTITY (RUN 2)



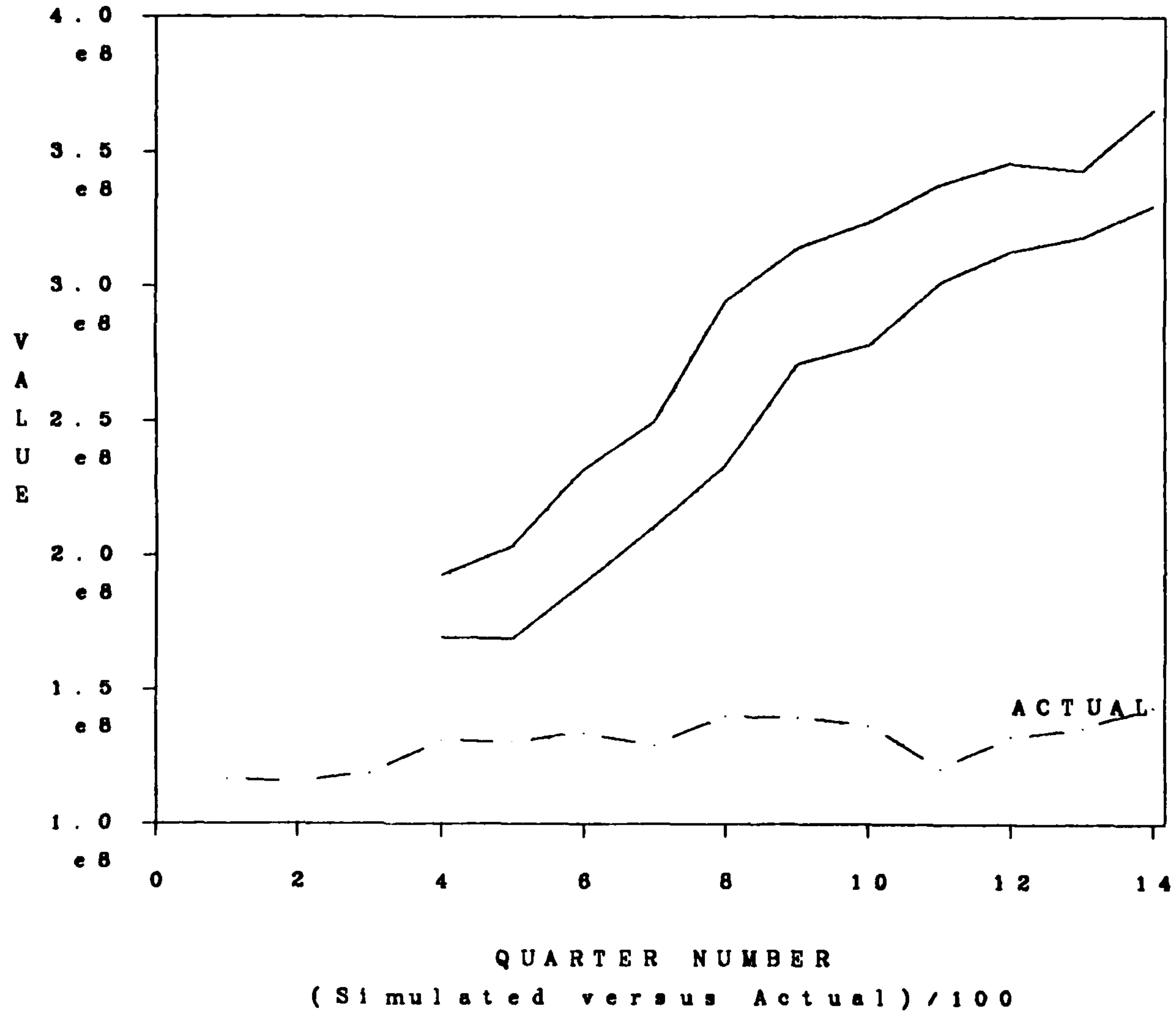
QUARTER NUMBER
95% Confidence Band of Simulation Results

SIMULATION RESULTS (SECOND ITEM GROUPING)

ANNUAL DEMAND VALUE BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	594010	3390692	611297	5018085	9000195	162586432	181200720
	ACTUAL	7226	3865751	667380	3365566	8748398	114670864	131325184
83-1	SIM	363573	2652862	531934	4896114	8437639	168445200	185327328
	ACTUAL	113649	4061098	673067	3653195	8440463	113786432	130727912
83-2	SIM	293143	2769272	476510	5093302	8212923	178635888	195481040
	ACTUAL	34012	4509959	663035	3521649	8125791	116912320	133766768
83-3	SIM	213099	2767752	472738	5219104	7906861	200643776	217223328
	ACTUAL	47756	4685676	602095	3238073	8936554	112067296	129577456
83-4	SIM	223985	2356576	465171	5549475	8069711	230875152	247540080
	ACTUAL	4406	4173377	628858	3906527	8664319	122958128	140335616
84-1	SIM	224180	2349220	443585	5814449	8669304	261734912	279235648
	ACTUAL	117438	3856301	651863	3975632	9737451	121541248	139879936
84-2	SIM	223961	2299561	428111	5868862	8373807	277778816	294973120
	ACTUAL	3071	3783336	600674	3929928	10564282	117688640	136569936
84-3	SIM	237898	2203370	414959	5799525	8604514	310850464	328110720
	ACTUAL	113723	3324610	563628	3656849	11293825	101913840	120866480
84-4	SIM	184658	2216662	391920	5981431	8675277	317362656	334812608
	ACTUAL	7840	3623736	580906	4197255	10061051	113911288	132382080
85-1	SIM	147399	2123970	383359	5761972	8812060	325494880	342723648
	ACTUAL	205523	3540096	624354	4164228	9832823	117296720	135663744
85-2	SIM	139344	2110929	368369	5818815	8507535	349621696	366566688
	ACTUAL	166702	3252831	626310	4241083	10345486	125191104	143823520

ANNUAL DEMAND VALUE (RUN 2)



SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND FREQUENCY GROUP ITEM COUNTS

QUARTER	SOURCE	0	1-9	10-19	20-199	200-UP
82-4	SIMULATED	22191	13364	1947	3069	338
	ACTUAL	24361	12980	1290	1829	449
	% DIFFERENCE	-8.91	2.96	50.93	67.80	-24.72
83-1	SAMULATED	24782	10859	1806	3110	352
	ACTUAL	23203	14096	1312	1841	457
	% DIFFERENCE	6.81	-22.96	37.65	68.93	-22.98
83-2	SIMULATED	25453	9966	1754	3359	377
	ACTUAL	23361	13866	1337	1880	465
	% DIFFERENCE	8.96	-28.13	31.19	78.67	-18.92
83-3	SIMULATED	25724	9450	1731	3603	401
	ACTUAL	22754	14375	1374	1925	481
	% DIFFERENCE	13.05	-34.26	25.98	87.17	-16.63
83-4	SIMULATED	25899	8932	1808	3825	445
	ACTUAL	23577	13581	1341	1929	481
	% DIFFERENCE	9.85	-34.23	34.82	98.29	-7.48
84-1	SIMULATED	25773	8834	1771	4025	506
	ACTUAL	23668	13452	1370	1933	486
	% DIFFERENCE	8.89	-34.33	29.27	108.23	4.12
84-2	SIMULATED	25669	8769	1795	4090	586
	ACTUAL	24465	12703	1362	1909	470
	% DIFFERENCE	4.92	-30.97	31.79	114.25	24.68
84-3	SIMULATED	25548	8792	1713	4204	652
	ACTUAL	24548	12596	1398	1897	470
	% DIFFERENCE	4.07	-30.20	22.53	121.61	38.72
84-4	SIMULATED	25356	8923	1667	4244	719
	ACTUAL	25093	12076	1403	1875	462
	% DIFFERENCE	1.05	-26.11	18.82	126.35	55.63
85-1	SIMULATED	25368	8813	1626	4308	794
	ACTUAL	25060	12145	1380	1869	455
	% DIFFERENCE	1.23	-27.44	17.83	130.50	74.51
85-2	SIMULATED	25364	8680	1627	4331	907
	ACTUAL	25664	11564	1380	1865	436
	% DIFFERENCE	-1.17	-24.94	17.90	132.23	108.03

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY ITEM COUNT SUMMARY

QUARTER		N-S	NSO	R/L	R/M	R/H1	R/H2
82-4	SIMULATED	4662	27999	3249	2671	901	1427
	ACTUAL	9259	24281	3338	1862	724	1445
83-1	SIMULATED	4542	27850	3315	2798	881	1523
	ACTUAL	7549	25791	3536	1847	685	1501
83-2	SIMULATED	4449	27704	3334	2906	868	1648
	ACTUAL	8510	24740	3548	1862	668	1581
83-3	SIMULATED	4342	27532	3406	2985	869	1775
	ACTUAL	8833	24369	3496	1870	741	1600
83-4	SIMULATED	4246	28618	2519	2771	849	1906
	ACTUAL	9292	23884	3552	1871	702	1608
84-1	SIMULATED	4161	28584	2490	2753	886	2035
	ACTUAL	9624	23204	3864	1931	764	1522
84-2	SIMULATED	4096	28569	2418	2785	861	2180
	ACTUAL	9805	23360	3567	1957	794	1426
84-3	SIMULATED	4029	28536	2343	2795	895	2311
	ACTUAL	9810	23316	3567	2012	907	1297
84-4	SIMULATED	3971	28471	2302	2818	901	2446
	ACTUAL	10940	22261	3503	2057	783	1365
85-1	SIMULATED	3910	28482	2212	2807	929	2569
	ACTUAL	10945	21959	3724	2123	784	1374
85-2	SIMULATED	3861	28474	2164	2790	903	2717
	ACTUAL	11085	21605	3934	2165	785	1335

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4662	0	667	420	61	18	5828
ACTUAL		6190	38	9	4	3	0	6244
SIMULATED	NSO	0	26939	926	531	103	32	28531
ACTUAL		2932	23890	269	140	19	16	27266
SIMULATED	R/L	0	869	1615	620	6	4	3114
ACTUAL		105	279	2827	140	1	1	3353
SIMULATED	R/M	0	172	41	1025	353	63	1654
ACTUAL		27	63	232	1499	93	12	1926
SIMULATED	R/H1	0	11	0	74	356	273	714
ACTUAL		5	8	1	77	560	184	835
SIMULATED	R/H2	0	8	0	1	22	1037	1068
ACTUAL		0	3	0	2	48	1232	1285

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	79.9931	0.0000	11.4447	7.2066	1.0467	0.3089
ACTUAL		99.1352	0.6086	0.1441	0.0641	0.0480	0.0000
SIMULATED	NSO	0.0000	94.4201	3.2456	1.8611	0.3610	0.1122
ACTUAL		10.7533	87.6183	0.9866	0.5135	0.0697	0.0587
SIMULATED	R/L	0.0000	27.9062	51.8626	19.9101	0.1927	0.1285
ACTUAL		3.1315	8.3209	84.3126	4.1754	0.0298	0.0298
SIMULATED	R/M	0.0000	10.3990	2.4788	61.9710	21.3422	3.8089
ACTUAL		1.4019	3.2710	12.0457	77.8297	4.8287	0.6231
SIMULATED	R/H1	0.0000	1.5406	0.0000	10.3641	49.8599	38.2353
ACTUAL		0.5988	0.9581	0.1198	9.2216	67.0659	22.0359
SIMULATED	R/H2	0.0000	0.7491	0.0000	0.0936	2.0599	97.0974
ACTUAL		0.0000	0.2335	0.0000	0.1556	3.7354	95.8755

TOTAL SQUARED DIFFERENCE = 0.365321

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4542	0	71	41	7	1	4662
ACTUAL		6237	2845	133	32	9	3	9259
SIMULATED	NSO	0	27633	201	129	27	9	27999
ACTUAL		1259	22546	295	143	24	14	24281
SIMULATED	R/L	0	142	2913	193	0	1	3249
ACTUAL		21	325	2847	144	1	0	3338
SIMULATED	R/M	0	66	129	2330	135	11	2671
ACTUAL		16	68	259	1442	72	5	1862
SIMULATED	R/H1	0	6	1	105	676	113	901
ACTUAL		5	7	2	83	497	130	724
SIMULATED	R/H2	0	3	0	0	36	1388	1427
ACTUAL		11	0	0	3	82	1349	1445

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.4260	0.0000	1.5230	0.8795	0.1502	0.0215
ACTUAL		67.3615	30.7269	1.4364	0.3456	0.0972	0.0324
SIMULATED	NSO	0.0000	98.6928	0.7179	0.4607	0.0964	0.0321
ACTUAL		5.1851	92.8545	1.2149	0.5889	0.0988	0.0577
SIMULATED	R/L	0.0000	4.3706	89.6584	5.9403	0.0000	0.0308
ACTUAL		0.6291	9.7364	85.2906	4.3140	0.0300	0.0000
SIMULATED	R/M	0.0000	2.4710	4.8297	87.2332	5.0543	0.4118
ACTUAL		0.8593	3.6520	13.9098	77.4436	3.8668	0.2685
SIMULATED	R/H1	0.0000	0.6659	0.1110	11.6537	75.0277	12.5416
ACTUAL		0.6906	0.9669	0.2762	11.4641	68.6464	17.9558
SIMULATED	R/H2	0.0000	0.2102	0.0000	0.0000	2.5228	97.2670
ACTUAL		0.7612	0.0000	0.0000	0.2076	5.6747	93.3564

TOTAL SQUARED DIFFERENCE = 0.223887

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4449	0	57	28	7	1	4542
ACTUAL		7376	115	23	11	4	20	7549
SIMULATED	NSO	0	27522	186	119	16	7	27850
ACTUAL		1110	24225	280	136	24	16	25791
SIMULATED	R/L	0	123	3000	189	2	1	3315
ACTUAL		16	326	3024	166	0	4	3536
SIMULATED	R/M	0	47	91	2495	149	16	2798
ACTUAL		6	61	220	1462	90	8	1847
SIMULATED	R/H1	0	9	0	75	671	126	881
ACTUAL		2	7	1	87	476	112	685
SIMULATED	R/H2	0	3	0	0	23	1497	1523
ACTUAL		0	6	0	0	74	1421	1501

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.9524	0.0000	1.2550	0.6165	0.1541	0.0220
ACTUAL		97.7083	1.5234	0.3047	0.1457	0.0530	0.2649
SIMULATED	NSO	0.0000	98.8223	0.6679	0.4273	0.0575	0.0251
ACTUAL		4.3038	93.9281	1.0856	0.5273	0.0931	0.0620
SIMULATED	R/L	0.0000	3.7104	90.4977	5.7014	0.0603	0.0302
ACTUAL		0.4525	9.2195	85.5204	4.6946	0.0000	0.1131
SIMULATED	R/M	0.0000	1.6798	3.2523	89.1708	5.3252	0.5718
ACTUAL		0.3249	3.3027	11.9112	79.1554	4.8728	0.4331
SIMULATED	R/H1	0.0000	1.0216	0.0000	8.5131	76.1635	14.3019
ACTUAL		0.2920	1.0219	0.1460	12.7007	69.4890	16.3504
SIMULATED	R/H2	0.0000	0.1970	0.0000	0.0000	1.5102	98.2928
ACTUAL		0.0000	0.3997	0.0000	0.0000	4.9300	94.6702

TOTAL SQUARED DIFFERENCE = 0.037209

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4342	0	52	46	8	1	4449
ACTUAL		8312	170	8	7	5	8	8510
SIMULATED	NSO	0	27368	195	110	23	8	27704
ACTUAL		508	23766	269	155	28	14	24740
SIMULATED	R/L	0	110	3051	169	2	2	3334
ACTUAL		13	353	2936	236	6	4	3548
SIMULATED	R/M	0	38	108	2600	145	15	2906
ACTUAL		0	67	281	1393	110	11	1862
SIMULATED	R/H1	0	16	0	60	674	118	868
ACTUAL		0	10	1	77	453	127	668
SIMULATED	R/H2	0	0	0	0	17	1631	1648
ACTUAL		0	3	1	2	139	1436	1581

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.5950	0.0000	1.1688	1.0339	0.1798	0.0225
ACTUAL		97.6733	1.9976	0.0940	0.0823	0.0588	0.0940
SIMULATED	NSO	0.0000	98.7872	0.7039	0.3971	0.0830	0.0289
ACTUAL		2.0534	96.0631	1.0873	0.6265	0.1132	0.0566
SIMULATED	R/L	0.0000	3.2993	91.5117	5.0690	0.0600	0.0600
ACTUAL		0.3664	9.9493	82.7508	6.6516	0.1691	0.1127
SIMULATED	R/M	0.0000	1.3076	3.7164	89.4701	4.9897	0.5162
ACTUAL		0.0000	3.5983	15.0913	74.8120	5.9076	0.5908
SIMULATED	R/H1	0.0000	1.8433	0.0000	6.9124	77.6498	13.5945
ACTUAL		0.0000	1.4970	0.1497	11.5269	67.8144	19.0120
SIMULATED	R/H2	0.0000	0.0000	0.0000	0.0000	1.0316	98.9684
ACTUAL		0.0000	0.1898	0.0633	0.1265	8.7919	90.8286

TOTAL SQUARED DIFFERENCE = 0.076594

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4246	0	49	39	7	1	4342
ACTUAL		8692	130	8	2	1	0	8833
SIMULATED	NSO	0	27186	202	109	25	10	27532
ACTUAL		554	23398	274	113	23	7	24369
SIMULATED	R/L	0	1006	2196	202	1	1	3406
ACTUAL		28	298	3006	162	2	0	3496
SIMULATED	R/M	0	378	71	2364	159	13	2985
ACTUAL		12	50	263	1482	63	0	1870
SIMULATED	R/H1	0	40	1	57	638	133	869
ACTUAL		3	7	0	107	518	106	741
SIMULATED	R/H2	0	8	0	0	19	1748	1775
ACTUAL		3	1	1	5	95	1495	1600

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.7890	0.0000	1.1285	0.8982	0.1612	0.0230
ACTUAL		98.4037	1.4718	0.0906	0.0226	0.0113	0.0000
SIMULATED	NSO	0.0000	98.7433	0.7337	0.3959	0.0908	0.0363
ACTUAL		2.2734	96.0154	1.1244	0.4637	0.0944	0.0287
SIMULATED	R/L	0.0000	29.5361	64.4745	5.9307	0.0294	0.0294
ACTUAL		0.8009	8.5240	85.9840	4.6339	0.0572	0.0000
SIMULATED	R/M	0.0000	12.6633	2.3786	79.1960	5.3266	0.4355
ACTUAL		0.6417	2.6738	14.0642	79.2513	3.3690	0.0000
SIMULATED	R/H1	0.0000	4.6030	0.1151	6.5593	73.4177	15.3049
ACTUAL		0.4049	0.9447	0.0000	14.4399	69.9055	14.3050
SIMULATED	R/H2	0.0000	0.4507	0.0000	0.0000	1.0704	98.4789
ACTUAL		0.1875	0.0625	0.0625	0.3125	5.9375	93.4375

TOTAL SQUARED DIFFERENCE = 0.130284

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4161	0	52	26	6	1	4246
ACTUAL		9136	143	9	4	0	0	9292
SIMULATED	NSO	0	28189	252	147	24	6	28618
ACTUAL		448	23010	267	128	26	5	23884
SIMULATED	R/L	0	272	2104	142	0	1	2519
ACTUAL		21	25	3352	154	0	0	3552
SIMULATED	R/M	0	112	82	2387	169	21	2771
ACTUAL		8	20	235	1528	78	2	1871
SIMULATED	R/H1	0	10	0	51	668	120	849
ACTUAL		4	4	1	114	521	58	702
SIMULATED	R/H2	0	1	0	0	19	1886	1906
ACTUAL		7	2	0	3	139	1457	1608

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.9981	0.0000	1.2247	0.6123	0.1413	0.0236
ACTUAL		98.3211	1.5390	0.0969	0.0430	0.0000	0.0000
SIMULATED	NSO	0.0000	98.5009	0.8806	0.5137	0.0839	0.0210
ACTUAL		1.8757	96.3406	1.1179	0.5359	0.1089	0.0209
SIMULATED	R/L	0.0000	10.7979	83.5252	5.6372	0.0000	0.0397
ACTUAL		0.5912	0.7038	94.3694	4.3356	0.0000	0.0000
SIMULATED	R/M	0.0000	4.0419	2.9592	86.1422	6.0989	0.7578
ACTUAL		0.4276	1.0689	12.5601	81.6676	4.1689	0.1069
SIMULATED	R/H1	0.0000	1.1779	0.0000	6.0071	78.6808	14.1343
ACTUAL		0.5698	0.5698	0.1425	16.2393	74.2165	8.2621
SIMULATED	R/H2	0.0000	0.0525	0.0000	0.0000	0.9969	98.9507
ACTUAL		0.4353	0.1244	0.0000	0.1866	8.6443	90.6095

TOTAL SQUARED DIFFERENCE = 0.064735

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4096	0	32	26	5	2	4161
ACTUAL		8587	1012	20	4	0	1	9624
SIMULATED	NSO	0	28209	222	136	15	2	28584
ACTUAL		1171	21671	217	117	22	6	23204
SIMULATED	R/L	0	276	2078	135	0	1	2490
ACTUAL		30	557	3100	174	3	0	3864
SIMULATED	R/M	0	74	86	2435	145	13	2753
ACTUAL		8	102	229	1526	63	3	1931
SIMULATED	R/H1	0	9	0	53	680	144	886
ACTUAL		2	12	1	131	552	66	764
SIMULATED	R/H2	0	1	0	0	16	2018	2035
ACTUAL		7	6	0	5	154	1350	1522

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.4379	0.0000	0.7690	0.6248	0.1202	0.0481
ACTUAL		89.2249	10.5154	0.2078	0.0416	0.0000	0.0104
SIMULATED	NSO	0.0000	98.6881	0.7767	0.4758	0.0525	0.0070
ACTUAL		5.0465	93.3934	0.9352	0.5042	0.0948	0.0259
SIMULATED	R/L	0.0000	11.0843	83.4538	5.4217	0.0000	0.0402
ACTUAL		0.7764	14.4151	80.2277	4.5031	0.0776	0.0000
SIMULATED	R/M	0.0000	2.6880	3.1239	88.4490	5.2670	0.4722
ACTUAL		0.4143	5.2822	11.8591	79.0264	3.2626	0.1554
SIMULATED	R/H1	0.0000	1.0158	0.0000	5.9819	76.7494	16.2528
ACTUAL		0.2618	1.5707	0.1309	17.1466	72.2513	8.6387
SIMULATED	R/H2	0.0000	0.0491	0.0000	0.0000	0.7862	99.1646
ACTUAL		0.4599	0.3942	0.0000	0.3285	10.1183	88.6991

TOTAL SQUARED DIFFERENCE = 0.084902

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4029	0	33	30	4	0	4096
ACTUAL		9659	136	7	1	1	1	9805
SIMULATED	NSO	0	28188	226	129	21	5	28569
ACTUAL		109	22822	249	148	24	8	23360
SIMULATED	R/L	0	254	2020	143	1	0	2418
ACTUAL		19	275	3049	221	3	0	3567
SIMULATED	R/M	0	78	64	2459	167	17	2785
ACTUAL		10	72	258	1500	105	12	1957
SIMULATED	R/H1	0	12	0	34	688	127	861
ACTUAL		5	9	3	133	564	80	794
SIMULATED	R/H2	0	4	0	0	14	2162	2180
ACTUAL		8	2	1	9	210	1196	1426

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.3643	0.0000	0.8057	0.7324	0.0977	0.0000
ACTUAL		98.5110	1.3870	0.0714	0.0102	0.0102	0.0102
SIMULATED	NSO	0.0000	98.6664	0.7911	0.4515	0.0735	0.0175
ACTUAL		0.4666	97.6969	1.0659	0.6336	0.1027	0.0342
SIMULATED	R/L	0.0000	10.5045	83.5401	5.9140	0.0414	0.0000
ACTUAL		0.5327	7.7096	85.4780	6.1957	0.0841	0.0000
SIMULATED	R/M	0.0000	2.8007	2.2980	88.2944	5.9964	0.6104
ACTUAL		0.5110	3.6791	13.1834	76.6479	5.3654	0.6132
SIMULATED	R/H1	0.0000	1.3937	0.0000	3.9489	79.9071	14.7503
ACTUAL		0.6297	1.1335	0.3778	16.7506	71.0327	10.0756
SIMULATED	R/H2	0.0000	0.1835	0.0000	0.0000	0.6422	99.1743
ACTUAL		0.5610	0.1403	0.0701	0.6311	14.7265	83.8710

TOTAL SQUARED DIFFERENCE = 0.097016

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	3971	0	27	24	4	3	4029
ACTUAL		9773	34	2	1	0	0	9810
SIMULATED	NSO	0	28128	252	130	18	8	28536
ACTUAL		1124	21805	224	142	13	8	23316
SIMULATED	R/L	0	254	1963	124	0	2	2343
ACTUAL		24	313	3055	174	1	0	3567
SIMULATED	R/M	0	75	60	2506	141	13	2795
ACTUAL		11	83	219	1617	72	10	2012
SIMULATED	R/H1	0	12	0	34	718	131	895
ACTUAL		2	19	3	120	621	142	907
SIMULATED	R/H2	0	2	0	0	20	2289	2311
ACTUAL		6	7	0	3	76	1205	1297

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.5604	0.0000	0.6701	0.5957	0.0993	0.0745
ACTUAL		99.6228	0.3466	0.0204	0.0102	0.0000	0.0000
SIMULATED	NSO	0.0000	98.5702	0.8831	0.4556	0.0631	0.0280
ACTUAL		4.8207	93.5195	0.9607	0.6090	0.0558	0.0343
SIMULATED	R/L	0.0000	10.8408	83.7815	5.2924	0.0000	0.0854
ACTUAL		0.6728	8.7749	85.6462	4.8780	0.0280	0.0000
SIMULATED	R/M	0.0000	2.6834	2.1467	89.6601	5.0447	0.4651
ACTUAL		0.5467	4.1252	10.8847	80.3678	3.5785	0.4970
SIMULATED	R/H1	0.0000	1.3408	0.0000	3.7989	80.2235	14.6369
ACTUAL		0.2205	2.0948	0.3308	13.2304	68.4675	15.6560
SIMULATED	R/H2	0.0000	0.0865	0.0000	0.0000	0.8654	99.0480
ACTUAL		0.4626	0.5397	0.0000	0.2313	5.8597	92.9067

TOTAL SQUARED DIFFERENCE = 0.051847

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	3910	0	36	21	4	0	3971
ACTUAL		10781	136	14	6	3	0	10940
SIMULATED	NSO	0	28118	219	112	13	9	28471
ACTUAL		114	21786	210	133	15	3	22261
SIMULATED	R/L	0	278	1898	119	4	3	2302
ACTUAL		25	18	3262	196	2	0	3503
SIMULATED	R/M	0	77	59	2515	152	15	2818
ACTUAL		13	16	236	1677	110	5	2057
SIMULATED	R/H1	0	8	0	40	742	111	901
ACTUAL		3	1	1	108	539	131	783
SIMULATED	R/H2	0	1	0	0	14	2431	2446
ACTUAL		9	2	1	3	115	1235	1365

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.4639	0.0000	0.9066	0.5288	0.1007	0.0000
ACTUAL		98.5466	1.2431	0.1280	0.0548	0.0274	0.0000
SIMULATED	NSO	0.0000	98.7601	0.7692	0.3934	0.0457	0.0316
ACTUAL		0.5121	97.8662	0.9434	0.5975	0.0674	0.0135
SIMULATED	R/L	0.0000	12.0765	82.4500	5.1694	0.1738	0.1303
ACTUAL		0.7137	0.5138	93.1202	5.5952	0.0571	0.0000
SIMULATED	R/M	0.0000	2.7324	2.0937	89.2477	5.3939	0.5323
ACTUAL		0.6320	0.7778	11.4730	81.5265	5.3476	0.2431
SIMULATED	R/H1	0.0000	0.8879	0.0000	4.4395	82.3529	12.3196
ACTUAL		0.3831	0.1277	0.1277	13.7931	68.8378	16.7305
SIMULATED	R/H2	0.0000	0.0409	0.0000	0.0000	0.5724	99.3868
ACTUAL		0.6593	0.1465	0.0733	0.2198	8.4249	90.4762

TOTAL SQUARED DIFFERENCE = 0.083559

SIMULATION RESULTS (SECOND ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2

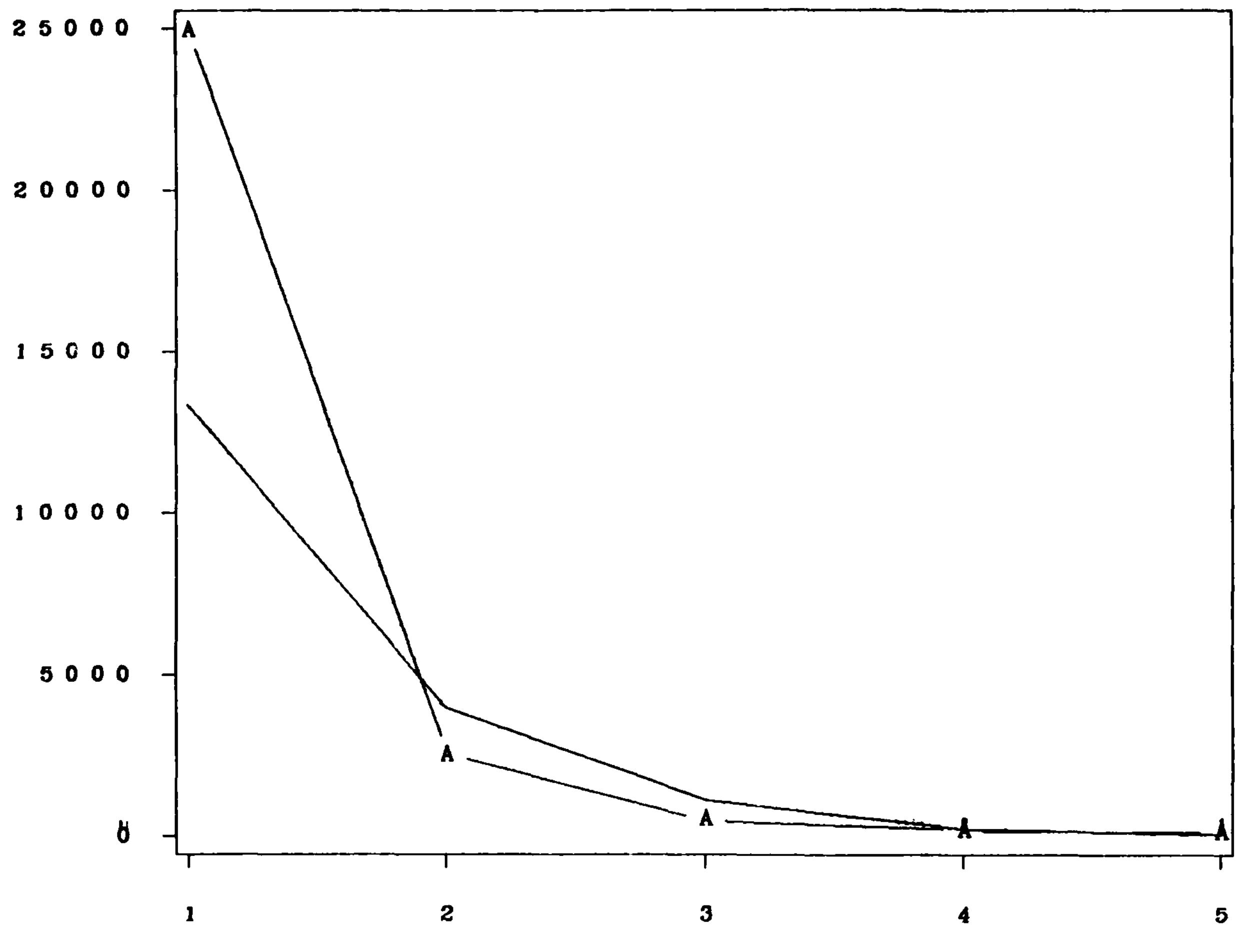
	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	3861	0	27	17	5	0	3910
ACTUAL		10747	182	11	2	1	2	10945
SIMULATED	NSO	0	28134	220	103	23	2	28482
ACTUAL		271	21363	175	121	24	5	21959
SIMULATED	R/L	0	242	1857	113	0	0	2212
ACTUAL		41	31	3486	165	1	0	3724
SIMULATED	R/M	0	93	60	2503	139	12	2807
ACTUAL		14	26	261	1735	80	7	2123
SIMULATED	R/H1	0	4	0	54	724	147	929
ACTUAL		4	2	1	139	553	85	784
SIMULATED	R/H2	0	1	0	0	12	2556	2569
ACTUAL		8	1	0	3	126	1236	1374

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.7468	0.0000	0.6905	0.4348	0.1279	0.0000
ACTUAL		98.1910	1.6629	0.1005	0.0183	0.0091	0.0183
SIMULATED	NSO	0.0000	98.7782	0.7724	0.3616	0.0808	0.0070
ACTUAL		1.2341	97.2858	0.7969	0.5510	0.1093	0.0228
SIMULATED	R/L	0.0000	10.9403	83.9512	5.1085	0.0000	0.0000
ACTUAL		1.1010	0.8324	93.6090	4.4307	0.0269	0.0000
SIMULATED	R/M	0.0000	3.3131	2.1375	89.1699	4.9519	0.4275
ACTUAL		0.6594	1.2247	12.2939	81.7240	3.7683	0.3297
SIMULATED	R/H1	0.0000	0.4306	0.0000	5.8127	77.9333	15.8235
ACTUAL		0.5102	0.2551	0.1276	17.7296	70.5357	10.8418
SIMULATED	R/H2	0.0000	0.0389	0.0000	0.0000	0.4671	99.4940
ACTUAL		0.5822	0.0728	0.0000	0.2183	9.1703	89.9563

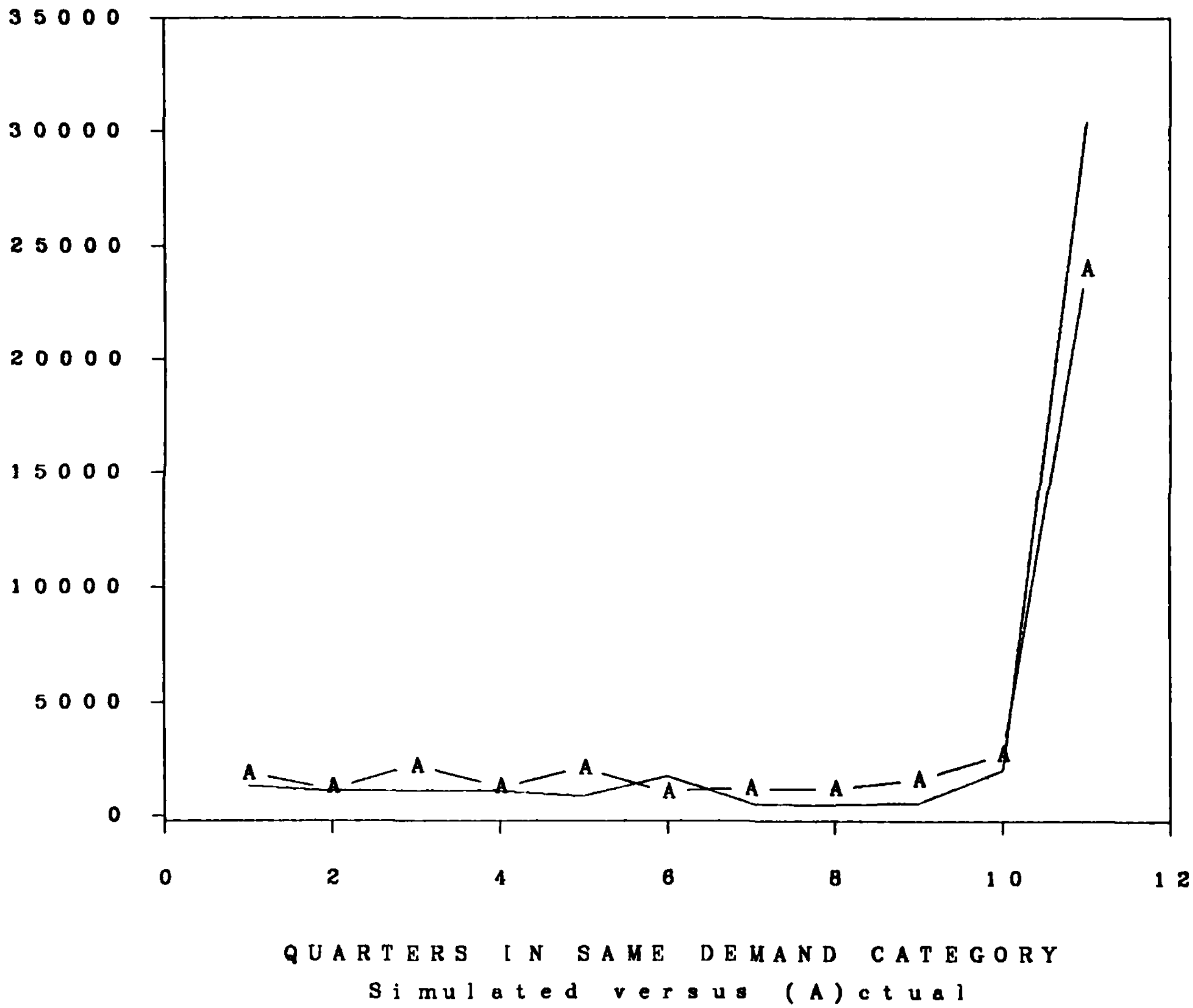
TOTAL SQUARED DIFFERENCE = 0.075828

DEMAND CATEGORY MIGRATION JUMP SIZE (RUN 2)



SIZE OF JUMP
Simulated versus (A)ctual

DEMAND CATEGORY STABILITY (RUN 2)

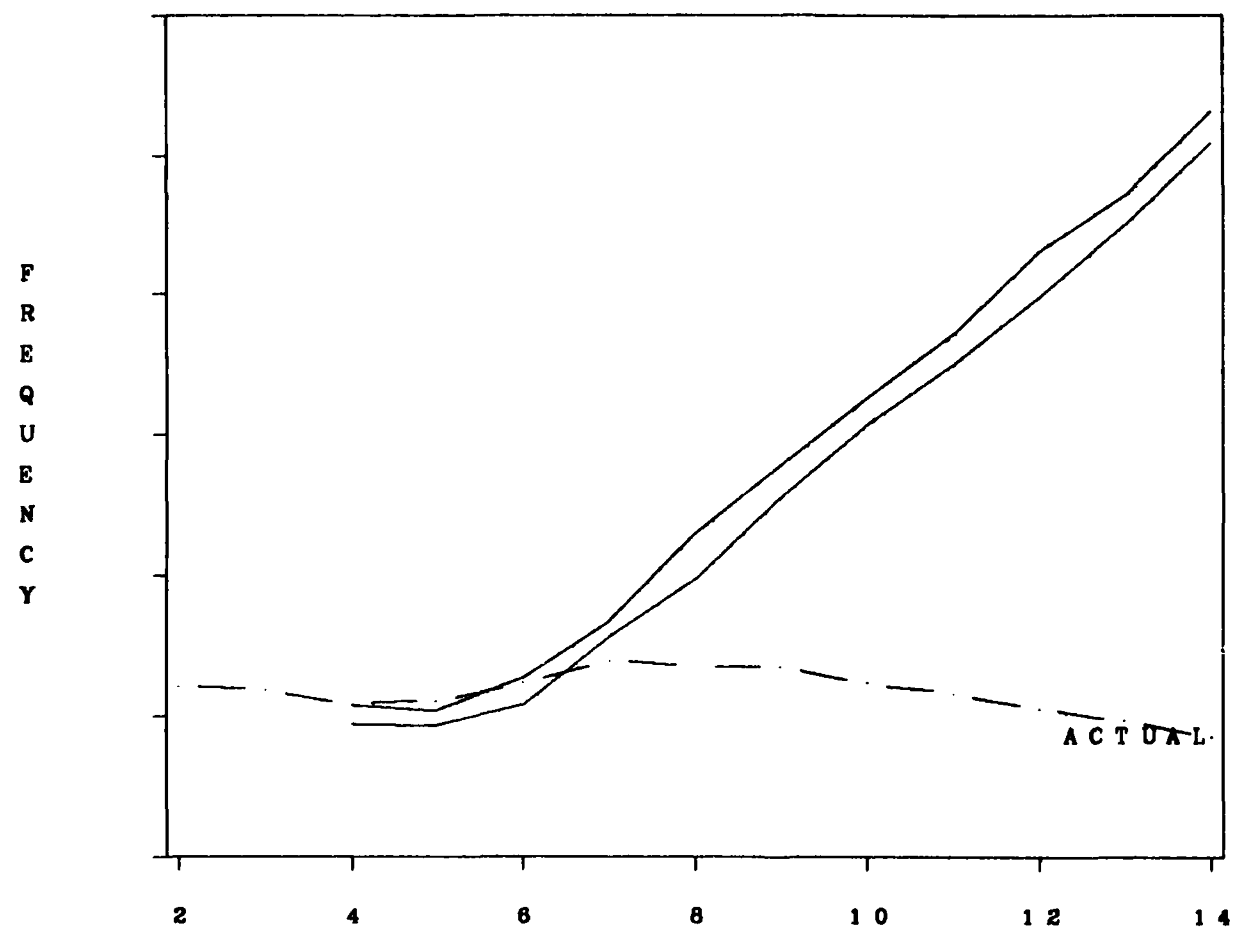


SIMULATION RESULTS (THIRD ITEM GROUPING)

ANNUAL DEMAND FREQUENCY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	3544	24570	40588	56962	43780	239388	408832
	ACTUAL	78	19879	25687	40235	65799	256901	408579
83-1	SIM	2141	17201	35845	57914	42122	248337	403560
	ACTUAL	523	20752	26565	40575	65603	257019	411037
83-2	SIM	1599	17203	32230	60311	40662	272194	424199
	ACTUAL	244	20916	24552	42285	65482	269867	423346
83-3	SIM	1381	14511	29027	65112	44404	306635	461070
	ACTUAL	378	21392	25299	43315	72383	277079	439846
83-4	SIM	1304	14149	27314	71894	47495	369037	531193
	ACTUAL	38	20309	26144	42729	65419	281619	436258
84-1	SIM	1186	13749	26910	76227	48791	416175	583038
	ACTUAL	843	19539	26732	44342	69344	274278	435078
84-2	SIM	1184	14401	25661	78562	46792	460729	627329
	ACTUAL	42	18831	27085	44721	70552	262244	423475
84-3	SIM	1116	14445	24617	80932	47313	503931	672354
	ACTUAL	882	18011	26894	42785	77912	249815	416299
84-4	SIM	991	14814	23531	80100	47134	532207	698777
	ACTUAL	120	17533	24814	44282	66554	252540	405843
85-1	SIM	869	14748	22361	81169	46410	584735	750292
	ACTUAL	1580	16593	24378	42753	63021	249382	397707
85-2	SIM	811	14799	21962	80500	48277	644001	810350
	ACTUAL	349	15816	23933	43458	61926	240759	386241

ANNUAL DEMAND FREQUENCY (RUN 3)



QUARTER NUMBER

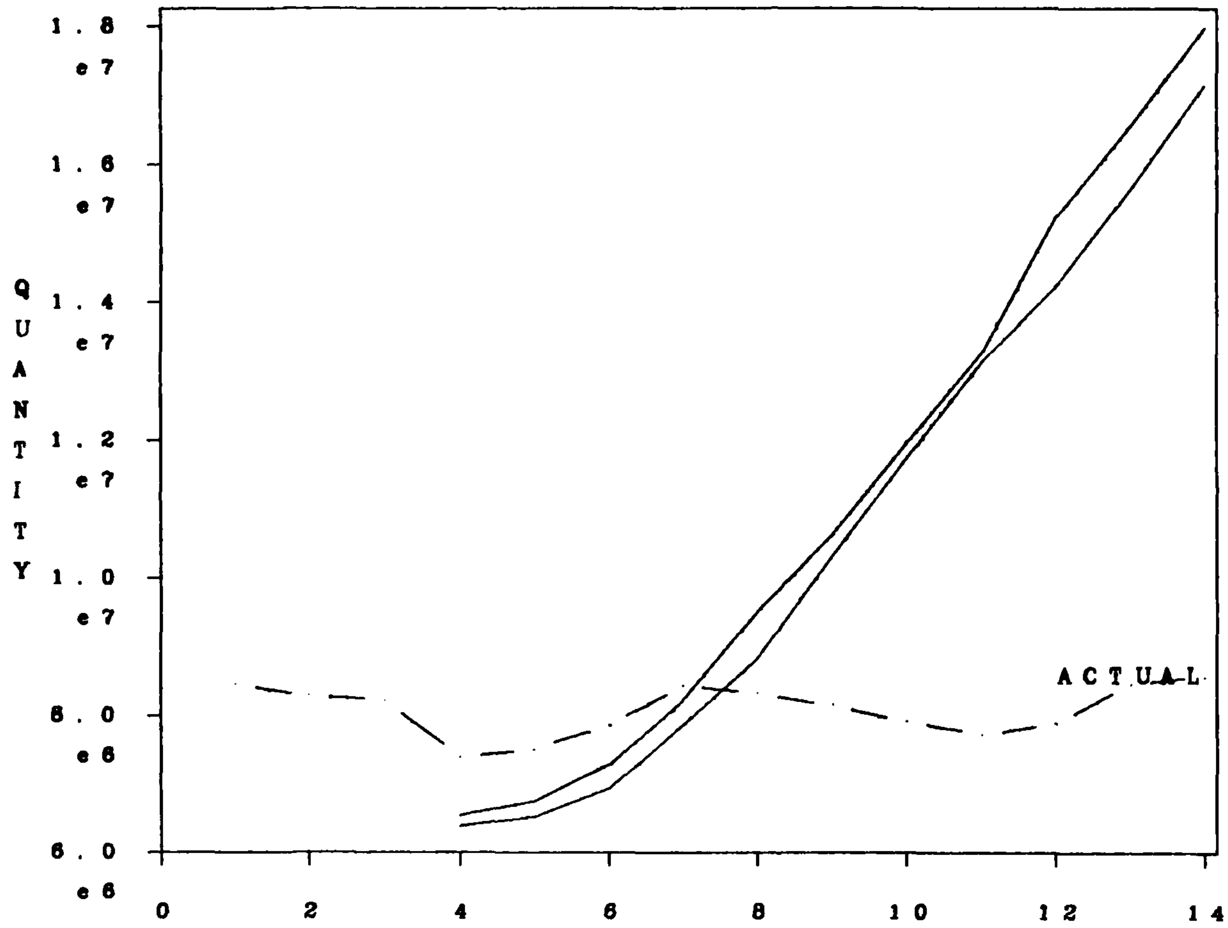
95% Confidence Band of Simulation Results

SIMULATION RESULTS (THIRD ITEM GROUPING)

ANNUAL DEMAND QUANTITY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	17996	109599	425461	778843	916061	4307861	6555821
	ACTUAL	1090	74105	254189	696862	2525225	3834572	7386043
83-1	SIM	8804	69686	383700	826856	817690	4610868	6717604
	ACTUAL	6364	75480	281169	661749	2648512	3825588	7498862
83-2	SIM	5829	158461	310463	799542	779534	5133309	7187138
	ACTUAL	3335	82093	226958	696557	2851641	4001940	7862524
83-3	SIM	5214	67824	265897	882948	841013	5916295	7979191
	ACTUAL	2228	90294	221293	695443	3408829	3998903	8416990
83-4	SIM	6115	49674	244936	989752	915051	7242792	9448320
	ACTUAL	127	83073	226318	678483	3207862	4110384	8306247
84-1	SIM	5685	47515	246119	1058118	915667	8398046	10671150
	ACTUAL	8961	79011	235355	722681	3158481	3940969	8145458
84-2	SIM	6911	53004	228800	1111797	814532	9726719	11941763
	ACTUAL	217	72123	258252	685591	3051590	3838691	7906464
84-3	SIM	6955	47553	211564	1157831	814808	10954845	13193556
	ACTUAL	10430	60277	254606	655512	3075785	3665599	7722209
84-4	SIM	5984	54214	196650	1131878	782375	12037678	14208779
	ACTUAL	603	60008	224907	682377	2997877	3930014	7895786
85-1	SIM	5633	57653	186283	1133170	735512	13733336	15851587
	ACTUAL	15790	57358	227069	724197	3245093	4167927	8437434
85-2	SIM	5591	50825	184157	1115246	773489	15194873	17324182
	ACTUAL	846	55751	231333	701261	3293255	4268149	8550595

ANNUAL DEMAND QUANTITY (RUN 3)



QUARTER NUMBER

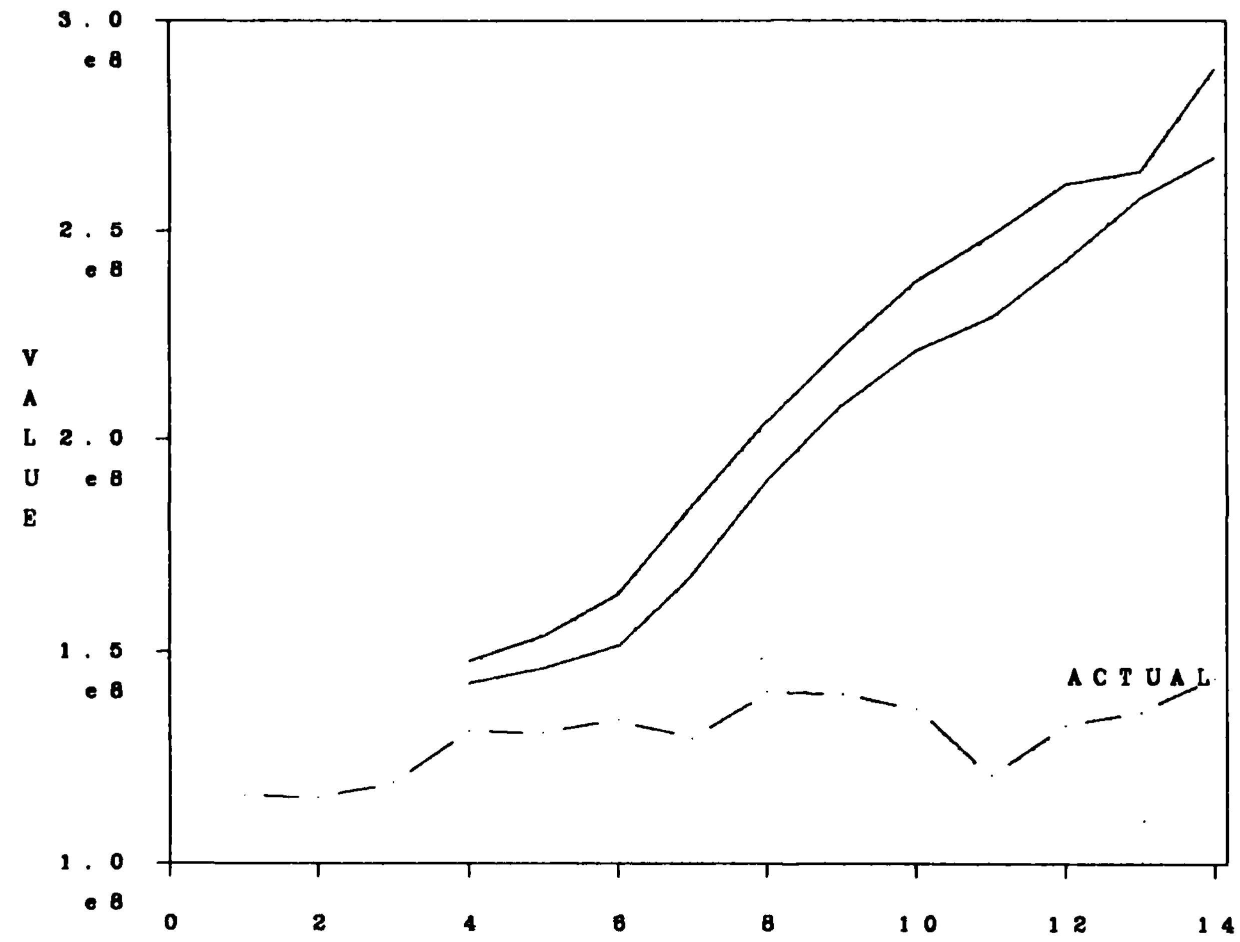
95% Confidence Band of Simulation Results

SIMULATION RESULTS (THIRD ITEM GROUPING)

ANNUAL DEMAND VALUE BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	442120	3911182	643606	5189165	9041574	125687672	144915328
	ACTUAL	7226	3865751	667380	3365566	8748398	114670864	131325184
83-1	SIM	292471	3162595	570127	5316198	8587028	131834768	149763184
	ACTUAL	113649	4061098	673067	3653195	8440463	113786432	130727912
83-2	SIM	220066	3282246	521150	5171495	8352767	143228032	160775760
	ACTUAL	34012	4509959	663035	3521649	8125791	116912320	133766768
83-3	SIM	185324	2530158	447581	5421341	8608002	157768848	174961264
	ACTUAL	47756	4685676	602095	3238073	8936554	112067296	129577456
83-4	SIM	170976	2531380	424498	5886576	8825669	184598096	202437200
	ACTUAL	4406	4173377	628858	3906527	8664319	122958128	140335616
84-1	SIM	151086	2393509	426603	6059855	8583196	203677280	221291536
	ACTUAL	117438	3856301	651863	3975632	9737451	121541248	139879936
84-2	SIM	134510	2234008	400813	6178524	8439273	216019360	233406496
	ACTUAL	3071	3783336	600674	3929928	10564282	117688640	136569936
84-3	SIM	126170	2387515	392634	6218520	8576696	228033984	245735520
	ACTUAL	113723	3324610	563628	3656849	11293825	101913840	120866480
84-4	SIM	92006	2556730	371817	5983466	8435119	234090336	251529472
	ACTUAL	7840	3623736	580906	4197255	10061051	113911288	132382080
85-1	SIM	80117	2437602	356822	6214110	8331117	240107504	257527280
	ACTUAL	205523	3540096	624354	4164228	9832823	117296720	135663744
85-2	SIM	84365	2363286	357624	6044320	8497084	256182016	273528704
	ACTUAL	166702	3252831	626310	4241083	10345486	125191104	143823520

ANNUAL DEMAND VALUE (RUN 3)



QUARTER NUMBER
(Simulated versus Actual)/100

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND FREQUENCY GROUP ITEM COUNTS

QUARTER	SOURCE	0	1-9	10-19	20-199	200-UP
82-4	SIMULATED	22204	13303	1997	3055	350
	ACTUAL	24361	12980	1290	1829	449
	% DIFFERENCE	-8.85	2.49	54.81	67.03	-22.05
83-1	SIMULATED	25336	10266	1863	3077	367
	ACTUAL	23203	14096	1312	1841	457
	% DIFFERENCE	9.19	-27.17	42.00	67.14	-19.69
83-2	SIMULATED	26408	9011	1775	3333	382
	ACTUAL	23361	13866	1337	1880	465
	% DIFFERENCE	13.04	-35.01	32.76	77.29	-17.85
83-3	SIMULATED	27031	8129	1753	3578	418
	ACTUAL	22754	14375	1374	1925	481
	% DIFFERENCE	18.80	-43.45	27.58	85.87	-13.10
83-4	SIMULATED	27135	7743	1760	3792	479
	ACTUAL	23577	13581	1341	1929	481
	% DIFFERENCE	15.09	-42.99	31.25	96.58	-0.42
84-1	SIMULATED	26955	7657	1808	3956	533
	ACTUAL	23668	13452	1370	1933	486
	% DIFFERENCE	13.89	-43.08	31.97	104.66	9.67
84-2	SIMULATED	26715	7773	1725	4079	617
	ACTUAL	24465	12703	1362	1909	470
	% DIFFERENCE	9.20	-38.81	26.65	113.67	31.28
84-3	SIMULATED	26375	8010	1646	4187	691
	ACTUAL	24548	12596	1398	1897	470
	% DIFFERENCE	7.44	-36.41	17.74	120.72	47.02
84-4	SIMULATED	26084	8226	1592	4238	769
	ACTUAL	25093	12076	1403	1875	462
	% DIFFERENCE	3.95	-31.88	13.47	126.03	66.45
85-1	SIMULATED	25894	8323	1544	4299	849
	ACTUAL	25060	12145	1380	1869	455
	% DIFFERENCE	3.33	-31.47	11.88	130.02	86.59
85-2	SIMULATED	25834	8280	1562	4309	924
	ACTUAL	25664	11564	1380	1865	436
	% DIFFERENCE	0.66	-28.40	13.19	131.05	111.93

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY ITEM COUNT SUMMARY

QUARTER		N-S	NSO	R/L	R/M	R/H1	R/H2
82-4	SIMULATED	4694	27655	3492	2789	914	1365
	ACTUAL	9259	24281	3338	1862	724	1445
83-1	SIMULATED	4585	27554	3561	2875	898	1436
	ACTUAL	7549	25791	3536	1847	685	1501
83-2	SIMULATED	4458	27440	3563	2979	898	1571
	ACTUAL	8510	24740	3548	1862	668	1581
83-3	SIMULATED	4362	27330	3500	3087	919	1711
	ACTUAL	8833	24369	3496	1870	741	1600
83-4	SIMULATED	4264	28725	2336	2836	905	1843
	ACTUAL	9292	23884	3552	1871	702	1608
84-1	SIMULATED	4176	28696	2286	2864	894	1993
	ACTUAL	9624	23204	3864	1931	764	1522
84-2	SIMULATED	4117	28693	2214	2858	892	2135
	ACTUAL	9805	23360	3567	1957	794	1426
84-3	SIMULATED	4057	28640	2201	2842	906	2263
	ACTUAL	9810	23316	3567	2012	907	1297
84-4	SIMULATED	3984	28612	2182	2800	913	2418
	ACTUAL	10940	22261	3503	2057	783	1365
85-1	SIMULATED	3932	28615	2105	2818	889	2550
	ACTUAL	10945	21959	3724	2123	784	1374
85-2	SIMULATED	3890	28572	2093	2776	905	2673
	ACTUAL	11085	21605	3934	2165	785	1335

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4694	0	578	456	76	24	5828
ACTUAL		6190	38	9	4	3	0	6244
SIMULATED	NSO	0	26600	1261	587	60	23	28531
ACTUAL		2932	23890	269	140	19	16	27266
SIMULATED	R/L	0	840	1618	637	14	5	3114
ACTUAL		105	279	2827	140	1	1	3353
SIMULATED	R/M	0	183	35	1044	354	38	1654
ACTUAL		27	63	232	1499	93	12	1926
SIMULATED	R/H1	0	21	0	63	396	234	714
ACTUAL		5	8	1	77	560	184	835
SIMULATED	R/H2	0	11	0	2	14	1041	1068
ACTUAL		0	3	0	2	48	1232	1285

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	80.5422	0.0000	9.9176	7.8243	1.3040	0.4118
ACTUAL		99.1352	0.6086	0.1441	0.0641	0.0480	0.0000
SIMULATED	NSO	0.0000	93.2319	4.4198	2.0574	0.2103	0.0806
ACTUAL		10.7533	87.6183	0.9866	0.5135	0.0697	0.0587
SIMULATED	R/L	0.0000	26.9750	51.9589	20.4560	0.4496	0.1606
ACTUAL		3.1315	8.3209	84.3126	4.1754	0.0298	0.0298
SIMULATED	R/M	0.0000	11.0641	2.1161	63.1197	21.4027	2.2975
ACTUAL		1.4019	3.2710	12.0457	77.8297	4.8287	0.6231
SIMULATED	R/H1	0.0000	2.9412	0.0000	8.8235	55.4622	32.7731
ACTUAL		0.5988	0.9581	0.1198	9.2216	67.0659	22.0359
SIMULATED	R/H2	0.0000	1.0300	0.0000	0.1873	1.3109	97.4719
ACTUAL		0.0000	0.2335	0.0000	0.1556	3.7354	95.8755

TOTAL SQUARED DIFFERENCE = 0.325333

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1

	FROM	N-S	NSO	R/L	R/M (TO)	R/H1	R/H2	TOTAL
SIMULATED	N-S	4585	0	49	56	3	1	4694
ACTUAL		6237	2845	133	32	9	3	9259
SIMULATED	NSO	0	27341	166	110	26	12	27655
ACTUAL		1259	22546	295	143	24	14	24281
SIMULATED	R/L	0	150	3161	179	0	2	3492
ACTUAL		21	325	2847	144	1	0	3338
SIMULATED	R/M	0	43	184	2441	118	3	2789
ACTUAL		16	68	259	1442	72	5	1862
SIMULATED	R/H1	0	14	1	87	717	95	914
ACTUAL		5	7	2	83	497	130	724
SIMULATED	R/H2	0	6	0	2	34	1323	1365
ACTUAL		11	0	0	3	82	1349	1445

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1 (PERCENT)

	FROM	N-S	NSO	R/L	R/M (TO)	R/H1	R/H2
SIMULATED	N-S	97.6779	0.0000	1.0439	1.1930	0.0639	0.0213
ACTUAL		67.3615	30.7269	1.4364	0.3456	0.0972	0.0324
SIMULATED	NSO	0.0000	98.8646	0.6003	0.3978	0.0940	0.0434
ACTUAL		5.1851	92.8545	1.2149	0.5889	0.0988	0.0577
SIMULATED	R/L	0.0000	4.2955	90.5212	5.1260	0.0000	0.0573
ACTUAL		0.6291	9.7364	85.2906	4.3140	0.0300	0.0000
SIMULATED	R/M	0.0000	1.5418	6.5973	87.5224	4.2309	0.1076
ACTUAL		0.8593	3.6520	13.9098	77.4436	3.8668	0.2685
SIMULATED	R/H1	0.0000	1.5317	0.1094	9.5186	78.4464	10.3939
ACTUAL		0.6906	0.9669	0.2762	11.4641	68.6464	17.9558
SIMULATED	R/H2	0.0000	0.4396	0.0000	0.1465	2.4908	96.9231
ACTUAL		0.7612	0.0000	0.0000	0.2076	5.6747	93.3564

TOTAL SQUARED DIFFERENCE = 0.232741

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4458	0	65	51	9	2	4585
ACTUAL		7376	115	23	11	4	20	7549
SIMULATED	NSO	0	27228	165	126	27	8	27554
ACTUAL		1110	24225	280	136	24	16	25791
SIMULATED	R/L	0	150	3215	192	1	3	3561
ACTUAL		16	326	3024	166	0	4	3536
SIMULATED	R/M	0	47	117	2540	149	22	2875
ACTUAL		6	61	220	1462	90	8	1847
SIMULATED	R/H1	0	10	1	70	700	117	898
ACTUAL		2	7	1	87	476	112	685
SIMULATED	R/H2	0	5	0	0	12	1419	1436
ACTUAL		0	6	0	0	74	1421	1501

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.2301	0.0000	1.4177	1.1123	0.1963	0.0436
ACTUAL		97.7083	1.5234	0.3047	0.1457	0.0530	0.2649
SIMULATED	NSO	0.0000	98.8169	0.5988	0.4573	0.0980	0.0290
ACTUAL		4.3038	93.9281	1.0856	0.5273	0.0931	0.0620
SIMULATED	R/L	0.0000	4.2123	90.2836	5.3917	0.0281	0.0842
ACTUAL		0.4525	9.2195	85.5204	4.6946	0.0000	0.1131
SIMULATED	R/M	0.0000	1.6348	4.0696	88.3478	5.1826	0.7652
ACTUAL		0.3249	3.3027	11.9112	79.1554	4.8728	0.4331
SIMULATED	R/H1	0.0000	1.1136	0.1114	7.7951	77.9510	13.0290
ACTUAL		0.2920	1.0219	0.1460	12.7007	69.4890	16.3504
SIMULATED	R/H2	0.0000	0.3482	0.0000	0.0000	0.8357	98.8162
ACTUAL		0.0000	0.3997	0.0000	0.0000	4.9300	94.6702

TOTAL SQUARED DIFFERENCE = 0.038575

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4362	0	51	37	6	2	4458
ACTUAL		8312	170	8	7	5	8	8510
SIMULATED	NSO	0	27134	148	131	14	13	27440
ACTUAL		508	23766	269	155	28	14	24740
SIMULATED	R/L	0	153	3227	183	0	0	3563
ACTUAL		13	353	2936	236	6	4	3548
SIMULATED	R/M	0	38	74	2701	150	16	2979
ACTUAL		0	67	281	1393	110	11	1862
SIMULATED	R/H1	0	5	0	35	734	124	898
ACTUAL		0	10	1	77	453	127	668
SIMULATED	R/H2	0	0	0	0	15	1556	1571
ACTUAL		0	3	1	2	139	1436	1581

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.8466	0.0000	1.1440	0.8300	0.1346	0.0449
ACTUAL		97.6733	1.9976	0.0940	0.0823	0.0588	0.0940
SIMULATED	NSO	0.0000	98.8848	0.5394	0.4774	0.0510	0.0474
ACTUAL		2.0534	96.0631	1.0873	0.6265	0.1132	0.0566
SIMULATED	R/L	0.0000	4.2941	90.5697	5.1361	0.0000	0.0000
ACTUAL		0.3664	9.9493	82.7508	6.6516	0.1691	0.1127
SIMULATED	R/M	0.0000	1.2756	2.4841	90.6680	5.0352	0.5371
ACTUAL		0.0000	3.5983	15.0913	74.8120	5.9076	0.5908
SIMULATED	R/H1	0.0000	0.5568	0.0000	3.8975	81.7372	13.8085
ACTUAL		0.0000	1.4970	0.1497	11.5269	67.8144	19.0120
SIMULATED	R/H2	0.0000	0.0000	0.0000	0.0000	0.9548	99.0452
ACTUAL		0.0000	0.1898	0.0633	0.1265	8.7919	90.8286

TOTAL SQUARED DIFFERENCE = 0.093932

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4264	0	47	46	3	2	4362
ACTUAL		8692	130	8	2	1	0	8833
SIMULATED	NSO	0	27000	191	113	20	6	27330
ACTUAL		554	23398	274	113	23	7	24369
SIMULATED	R/L	0	1303	2018	178	1	0	3500
ACTUAL		28	298	3006	162	2	0	3496
SIMULATED	R/M	0	389	80	2447	158	13	3087
ACTUAL		12	50	263	1482	63	0	1870
SIMULATED	R/H1	0	27	0	52	706	134	919
ACTUAL		3	7	0	107	518	106	741
SIMULATED	R/H2	0	6	0	0	17	1688	1711
ACTUAL		3	1	1	5	95	1495	1600

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.7533	0.0000	1.0775	1.0546	0.0688	0.0459
ACTUAL		98.4037	1.4718	0.0906	0.0226	0.0113	0.0000
SIMULATED	NSO	0.0000	98.7925	0.6989	0.4135	0.0732	0.0220
ACTUAL		2.2734	96.0154	1.1244	0.4637	0.0944	0.0287
SIMULATED	R/L	0.0000	37.2286	57.6571	5.0857	0.0286	0.0000
ACTUAL		0.8009	8.5240	85.9840	4.6339	0.0572	0.0000
SIMULATED	R/M	0.0000	12.6012	2.5915	79.2679	5.1182	0.4211
ACTUAL		0.6417	2.6738	14.0642	79.2513	3.3690	0.0000
SIMULATED	R/H1	0.0000	2.9380	0.0000	5.6583	76.8226	14.5811
ACTUAL		0.4049	0.9447	0.0000	14.4399	69.9055	14.3050
SIMULATED	R/H2	0.0000	0.3507	0.0000	0.0000	0.9936	98.6558
ACTUAL		0.1875	0.0625	0.0625	0.3125	5.9375	93.4375

TOTAL SQUARED DIFFERENCE = 0.205980

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4176	0	47	34	5	2	4264
ACTUAL		9136	143	9	4	0	0	9292
SIMULATED	NSO	0	28352	230	125	11	7	28725
ACTUAL		448	23010	267	128	26	5	23884
SIMULATED	R/L	0	236	1931	166	1	2	2336
ACTUAL		21	25	3352	154	0	0	3552
SIMULATED	R/M	0	86	78	2489	169	14	2836
ACTUAL		8	20	235	1528	78	2	1871
SIMULATED	R/H1	0	16	0	50	693	146	905
ACTUAL		4	4	1	114	521	58	702
SIMULATED	R/H2	0	6	0	0	15	1822	1843
ACTUAL		7	2	0	3	139	1457	1608

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	97.9362	0.0000	1.1023	0.7974	0.1173	0.0469
ACTUAL		98.3211	1.5390	0.0969	0.0430	0.0000	0.0000
SIMULATED	NSO	0.0000	98.7015	0.8007	0.4352	0.0383	0.0244
ACTUAL		1.8757	96.3406	1.1179	0.5359	0.1089	0.0209
SIMULATED	R/L	0.0000	10.1027	82.6627	7.1062	0.0428	0.0856
ACTUAL		0.5912	0.7038	94.3694	4.3356	0.0000	0.0000
SIMULATED	R/M	0.0000	3.0324	2.7504	87.7645	5.9591	0.4937
ACTUAL		0.4276	1.0689	12.5601	81.6676	4.1689	0.1069
SIMULATED	R/H1	0.0000	1.7680	0.0000	5.5249	76.5746	16.1326
ACTUAL		0.5698	0.5698	0.1425	16.2393	74.2165	8.2621
SIMULATED	R/H2	0.0000	0.3256	0.0000	0.0000	0.8139	98.8606
ACTUAL		0.4353	0.1244	0.0000	0.1866	8.6443	90.6095

TOTAL SQUARED DIFFERENCE = 0.070128

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4117	0	29	27	2	1	4176
ACTUAL		8587	1012	20	4	0	1	9624
SIMULATED	NSO	0	28340	208	125	15	8	28696
ACTUAL		1171	21671	217	117	22	6	23204
SIMULATED	R/L	0	239	1906	138	2	1	2286
ACTUAL		30	557	3100	174	3	0	3864
SIMULATED	R/M	0	95	71	2525	163	10	2864
ACTUAL		8	102	229	1526	63	3	1931
SIMULATED	R/H1	0	15	0	43	700	136	894
ACTUAL		2	12	1	131	552	66	764
SIMULATED	R/H2	0	4	0	0	10	1979	1993
ACTUAL		7	6	0	5	154	1350	1522

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.5872	0.0000	0.6944	0.6466	0.0479	0.0239
ACTUAL		89.2249	10.5154	0.2078	0.0416	0.0000	0.0104
SIMULATED	NSO	0.0000	98.7594	0.7248	0.4356	0.0523	0.0279
ACTUAL		5.0465	93.3934	0.9352	0.5042	0.0948	0.0259
SIMULATED	R/L	0.0000	10.4549	83.3771	6.0367	0.0875	0.0437
ACTUAL		0.7764	14.4151	80.2277	4.5031	0.0776	0.0000
SIMULATED	R/M	0.0000	3.3170	2.4791	88.1634	5.6913	0.3492
ACTUAL		0.4143	5.2822	11.8591	79.0264	3.2626	0.1554
SIMULATED	R/H1	0.0000	1.6779	0.0000	4.8098	78.2998	15.2125
ACTUAL		0.2618	1.5707	0.1309	17.1466	72.2513	8.6387
SIMULATED	R/H2	0.0000	0.2007	0.0000	0.0000	0.5018	99.2975
ACTUAL		0.4599	0.3942	0.0000	0.3285	10.1183	88.6991

TOTAL SQUARED DIFFERENCE = 0.090040

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	4057	0	35	23	2	0	4117
ACTUAL		9659	136	7	1	1	1	9805
SIMULATED	NSO	0	28314	236	123	15	5	28693
ACTUAL		109	22822	249	148	24	8	23360
SIMULATED	R/L	0	219	1866	128	1	0	2214
ACTUAL		19	275	3049	221	3	0	3567
SIMULATED	R/M	0	94	64	2522	159	19	2858
ACTUAL		10	72	258	1500	105	12	1957
SIMULATED	R/H1	0	8	0	46	717	121	892
ACTUAL		5	9	3	133	564	80	794
SIMULATED	R/H2	0	5	0	0	12	2118	2135
ACTUAL		8	2	1	9	210	1196	1426

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.5426	0.0000	0.8501	0.5587	0.0486	0.0000
ACTUAL		98.5110	1.3870	0.0714	0.0102	0.0102	0.0102
SIMULATED	NSO	0.0000	98.6791	0.8225	0.4287	0.0523	0.0174
ACTUAL		0.4666	97.6969	1.0659	0.6336	0.1027	0.0342
SIMULATED	R/L	0.0000	9.8916	84.2818	5.7814	0.0452	0.0000
ACTUAL		0.5327	7.7096	85.4780	6.1957	0.0841	0.0000
SIMULATED	R/M	0.0000	3.2890	2.2393	88.2435	5.5633	0.6648
ACTUAL		0.5110	3.6791	13.1834	76.6479	5.3654	0.6132
SIMULATED	R/H1	0.0000	0.8969	0.0000	5.1570	80.3812	13.5650
ACTUAL		0.6297	1.1335	0.3778	16.7506	71.0327	10.0756
SIMULATED	R/H2	0.0000	0.2342	0.0000	0.0000	0.5621	99.2037
ACTUAL		0.5610	0.1403	0.0701	0.6311	14.7265	83.8710

TOTAL SQUARED DIFFERENCE = 0.093649

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4

	FROM	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
					TO			
SIMULATED	N-S	3984	0	41	25	5	2	4057
ACTUAL		9773	34	2	1	0	0	9810
SIMULATED	NSO	0	28295	212	110	18	5	28640
ACTUAL		1124	21805	224	142	13	8	23316
SIMULATED	R/L	0	216	1865	119	1	0	2201
ACTUAL		24	313	3055	174	1	0	3567
SIMULATED	R/M	0	83	64	2499	177	19	2842
ACTUAL		11	83	219	1617	72	10	2012
SIMULATED	R/H1	0	14	0	47	703	142	906
ACTUAL		2	19	3	120	621	142	907
SIMULATED	R/H2	0	4	0	0	9	2250	2263
ACTUAL		6	7	0	3	76	1205	1297

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4 (PERCENT)

	FROM	N-S	NSO	R/L	R/M	R/H1	R/H2
					TO		
SIMULATED	N-S	98.2006	0.0000	1.0106	0.6162	0.1232	0.0493
ACTUAL		99.6228	0.3466	0.0204	0.0102	0.0000	0.0000
SIMULATED	NSO	0.0000	98.7954	0.7402	0.3841	0.0628	0.0175
ACTUAL		4.8207	93.5195	0.9607	0.6090	0.0558	0.0343
SIMULATED	R/L	0.0000	9.8137	84.7342	5.4066	0.0454	0.0000
ACTUAL		0.6728	8.7749	85.6462	4.8780	0.0280	0.0000
SIMULATED	R/M	0.0000	2.9205	2.2519	87.9310	6.2280	0.6685
ACTUAL		0.5467	4.1252	10.8847	80.3678	3.5785	0.4970
SIMULATED	R/H1	0.0000	1.5453	0.0000	5.1876	77.5938	15.6733
ACTUAL		0.2205	2.0948	0.3308	13.2304	68.4675	15.6560
SIMULATED	R/H2	0.0000	0.1768	0.0000	0.0000	0.3977	99.4255
ACTUAL		0.4626	0.5397	0.0000	0.2313	5.8597	92.9067

TOTAL SQUARED DIFFERENCE = 0.041902

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	3932	0	22	28	2	0	3984
ACTUAL		10781	136	14	6	3	0	10940
SIMULATED	NSO	0	28259	207	128	13	5	28612
ACTUAL		114	21786	210	133	15	3	22261
SIMULATED	R/L	0	269	1811	102	0	0	2182
ACTUAL		25	18	3262	196	2	0	3503
SIMULATED	R/M	0	82	65	2505	138	10	2800
ACTUAL		13	16	236	1677	110	5	2057
SIMULATED	R/H1	0	4	0	55	727	127	913
ACTUAL		3	1	1	108	539	131	783
SIMULATED	R/H2	0	1	0	0	9	2408	2418
ACTUAL		9	2	1	3	115	1235	1365

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.6948	0.0000	0.5522	0.7028	0.0502	0.0000
ACTUAL		98.5466	1.2431	0.1280	0.0548	0.0274	0.0000
SIMULATED	NSO	0.0000	98.7662	0.7235	0.4474	0.0454	0.0175
ACTUAL		0.5121	97.8662	0.9434	0.5975	0.0674	0.0135
SIMULATED	R/L	0.0000	12.3281	82.9973	4.6746	0.0000	0.0000
ACTUAL		0.7137	0.5138	93.1202	5.5952	0.0571	0.0000
SIMULATED	R/M	0.0000	2.9286	2.3214	89.4643	4.9286	0.3571
ACTUAL		0.6320	0.7778	11.4730	81.5265	5.3476	0.2431
SIMULATED	R/H1	0.0000	0.4381	0.0000	6.0241	79.6276	13.9102
ACTUAL		0.3831	0.1277	0.1277	13.7931	68.8378	16.7305
SIMULATED	R/H2	0.0000	0.0414	0.0000	0.0000	0.3722	99.5864
ACTUAL		0.6593	0.1465	0.0733	0.2198	8.4249	90.4762

TOTAL SQUARED DIFFERENCE = 0.073203

SIMULATION RESULTS (THIRD ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2

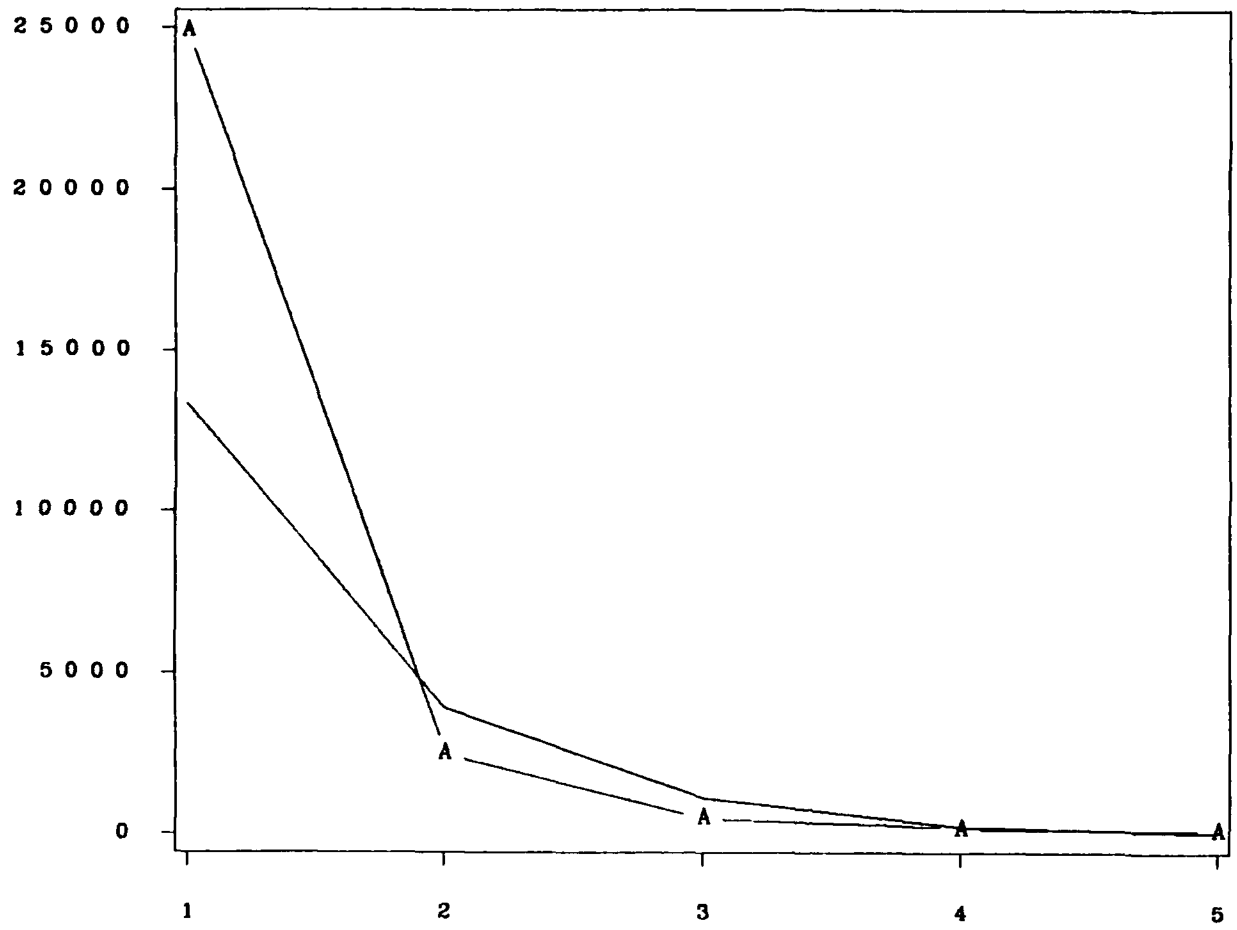
	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	3890	0	23	17	2	0	3932
ACTUAL		10747	182	11	2	1	2	10945
SIMULATED	NSO	0	28226	258	108	19	4	28615
ACTUAL		271	21363	175	121	24	5	21959
SIMULATED	R/L	0	244	1754	105	1	1	2105
ACTUAL		41	31	3486	165	1	0	3724
SIMULATED	R/M	0	92	58	2496	162	10	2818
ACTUAL		14	26	261	1735	80	7	2123
SIMULATED	R/H1	0	8	0	50	711	120	889
ACTUAL		4	2	1	139	553	85	784
SIMULATED	R/H2	0	2	0	0	10	2538	2550
ACTUAL		8	1	0	3	126	1236	1374

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.9318	0.0000	0.5849	0.4323	0.0509	0.0000
ACTUAL		98.1910	1.6629	0.1005	0.0183	0.0091	0.0183
SIMULATED	NSO	0.0000	98.6406	0.9016	0.3774	0.0664	0.0140
ACTUAL		1.2341	97.2858	0.7969	0.5510	0.1093	0.0228
SIMULATED	R/L	0.0000	11.5914	83.3254	4.9881	0.0475	0.0475
ACTUAL		1.1010	0.8324	93.6090	4.4307	0.0269	0.0000
SIMULATED	R/M	0.0000	3.2647	2.0582	88.5735	5.7488	0.3549
ACTUAL		0.6594	1.2247	12.2939	81.7240	3.7683	0.3297
SIMULATED	R/H1	0.0000	0.8999	0.0000	5.6243	79.9775	13.4983
ACTUAL		0.5102	0.2551	0.1276	17.7296	70.5357	10.8418
SIMULATED	R/H2	0.0000	0.0784	0.0000	0.0000	0.3922	99.5294
ACTUAL		0.5822	0.0728	0.0000	0.2183	9.1703	89.9563

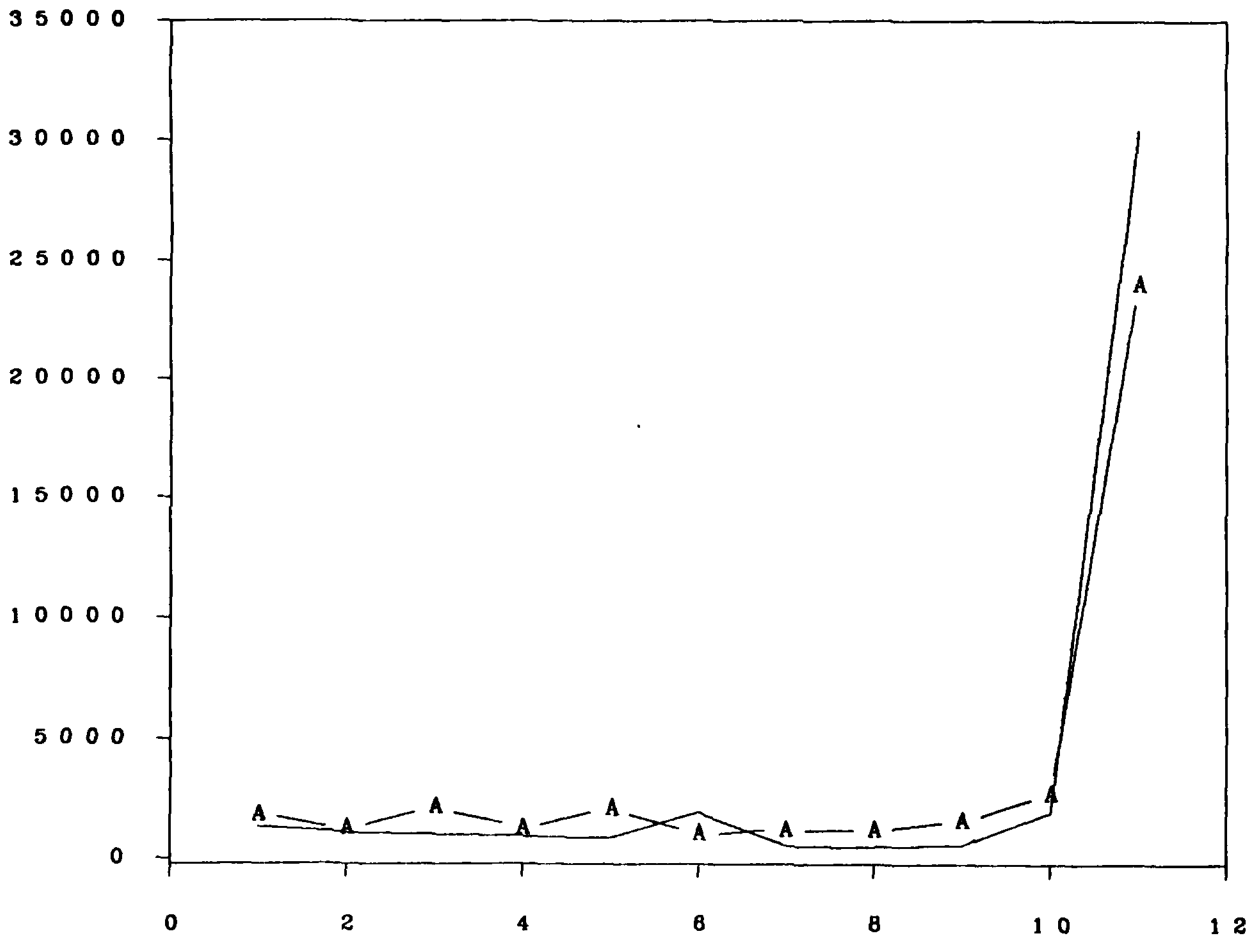
TOTAL SQUARED DIFFERENCE = 0.080288

DEMAND CATEGORY MIGRATION JUMP SIZE (RUN 3)



SIZE OF JUMP
Simulated versus (A)ctual

DEMAND CATEGORY STABILITY (RUN 3)



QUARTERS IN SAME DEMAND CATEGORY

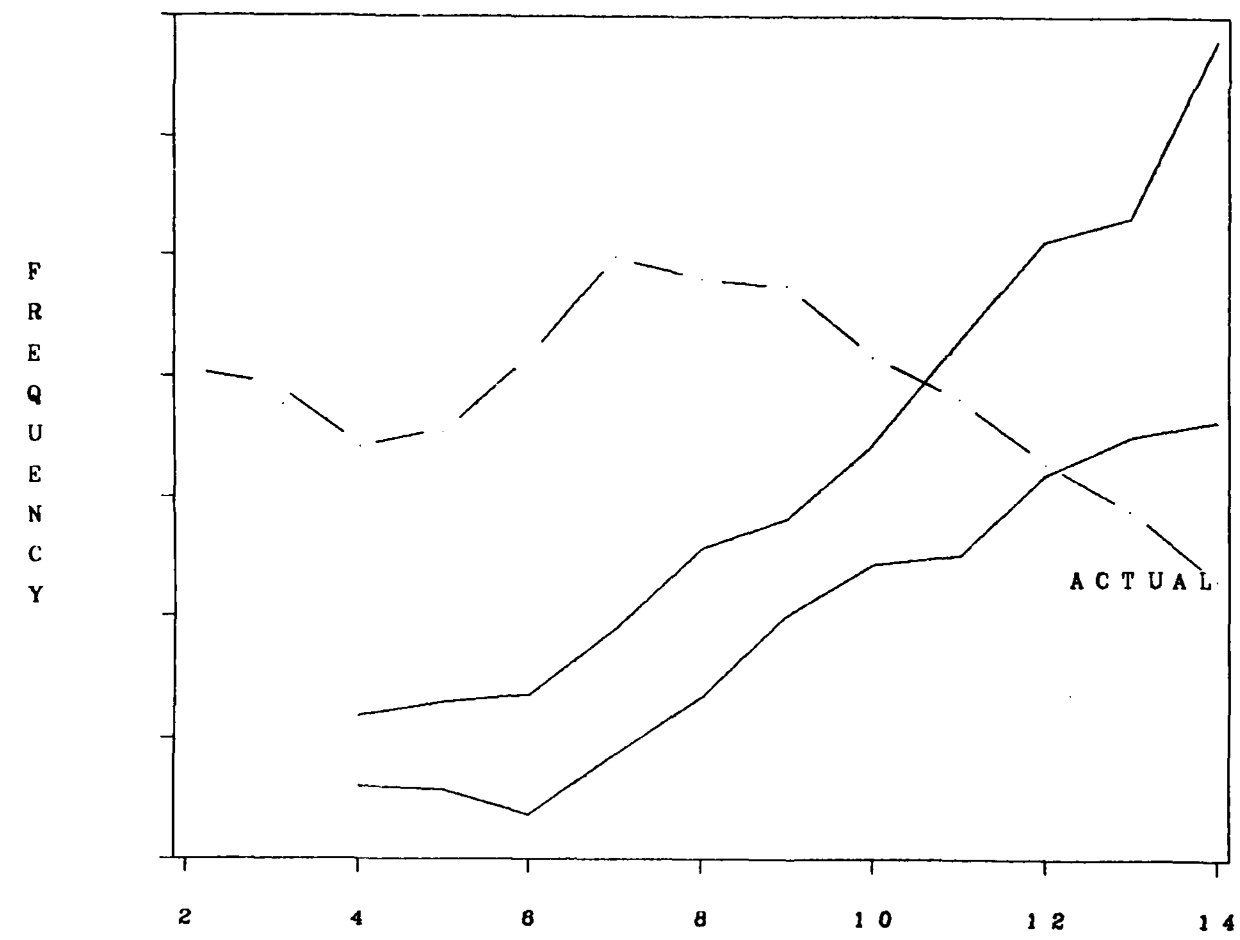
Simulated versus (A)ctual

SIMULATION RESULTS (FOURTH ITEM GROUPING)

ANNUAL DEMAND FREQUENCY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	2448	18993	28786	41213	44671	224156	360267
	ACTUAL	78	19879	25687	40235	65799	256901	408579
83-1	SIM	1525	16169	26831	40798	42597	228129	356049
	ACTUAL	523	20752	26565	40575	65603	257019	411037
83-2	SIM	1266	14848	25448	41507	37779	227684	348532
	ACTUAL	244	20916	24552	42285	65482	269867	423346
83-3	SIM	1209	15240	24678	41294	38526	240651	361598
	ACTUAL	378	21392	25299	43315	72383	277079	439846
83-4	SIM	1305	16128	23169	41609	39911	252527	374649
	ACTUAL	38	20309	26144	42729	65419	281619	436258
84-1	SIM	1365	16166	21356	42810	40843	262600	385140
	ACTUAL	843	19539	26732	44342	69344	274278	435078
84-2	SIM	1532	16810	20286	43541	41592	272253	396014
	ACTUAL	42	18831	27085	44721	70552	262244	423475
84-3	SIM	1616	16729	18927	44252	41121	276787	399432
	ACTUAL	882	18011	26894	42785	77912	249815	416299
84-4	SIM	1686	16657	18625	44593	39075	300643	421279
	ACTUAL	120	17533	24814	44282	66554	252540	405843
85-1	SIM	1735	17052	17436	45802	39574	306349	427948
	ACTUAL	1580	16593	24378	42753	63021	249382	397707
85-2	SIM	1738	16967	17534	45906	40253	317135	439533
	ACTUAL	349	15816	23933	43458	61926	240759	386241

ANNUAL DEMAND FREQUENCY (RUN 4)



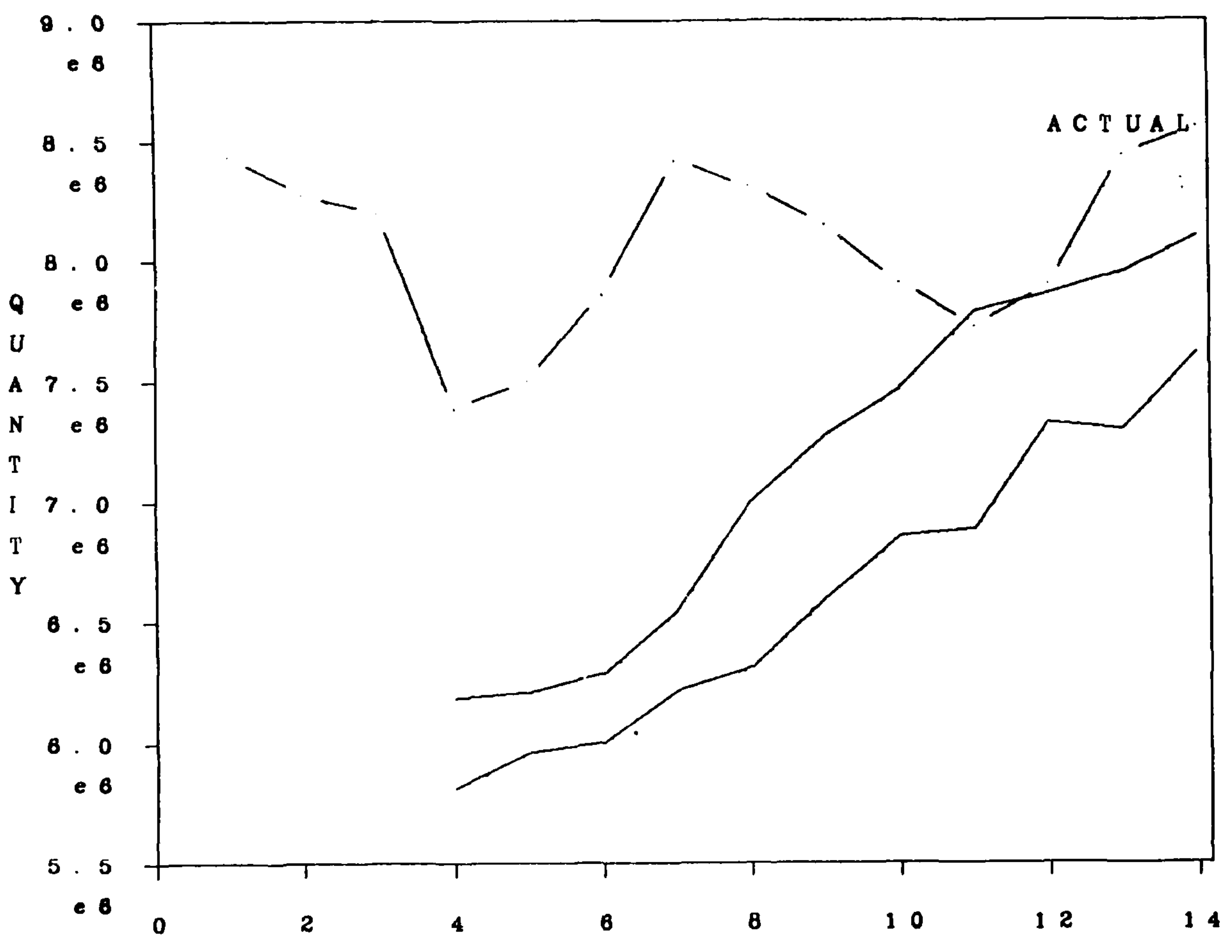
95% Confidence Band of Simulation Results

SIMULATION RESULTS (FOURTH ITEM GROUPING)

ANNUAL DEMAND QUANTITY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	12126	76494	326641	553429	1071881	3810970	5851541
	ACTUAL	1090	74105	254189	696862	2525225	3834572	7386043
83-1	SIM	7748	120164	296033	578899	916894	4087556	6007294
	ACTUAL	6364	75480	281169	661749	2648512	3825588	7498862
83-2	SIM	6679	126000	285937	576417	750806	4275276	6021115
	ACTUAL	3335	82093	226958	696557	2851641	4001940	7862524
83-3	SIM	6297	183928	261758	537249	826992	4606039	6422263
	ACTUAL	2228	90294	221293	695443	3408829	3998903	8416990
83-4	SIM	5629	192700	246338	513744	853031	4906495	6717937
	ACTUAL	127	83073	226318	678483	3207862	4110384	8306247
84-1	SIM	6008	197063	212961	536024	825026	5309335	7086417
	ACTUAL	8961	79011	235355	722681	3158481	3940969	8145458
84-2	SIM	7115	211477	188639	545010	837193	5452294	7241728
	ACTUAL	217	72123	258252	685591	3051590	3838691	7906464
84-3	SIM	8430	211190	164567	553478	860763	5396467	7194895
	ACTUAL	10430	60277	254606	655512	3075785	3665599	7722209
84-4	SIM	8834	211256	162714	568733	740419	5950853	7642809
	ACTUAL	603	60008	224907	682377	2997877	3930014	7895786
85-1	SIM	9552	214602	146949	585735	811755	5732776	7501369
	ACTUAL	15790	57358	227069	724197	3245093	4167927	8437434
85-2	SIM	9107	212883	152665	586138	785483	6000839	7747115
	ACTUAL	846	55751	231333	701261	3293255	4268149	8550595

ANNUAL DEMAND QUANTITY (RUN 4)



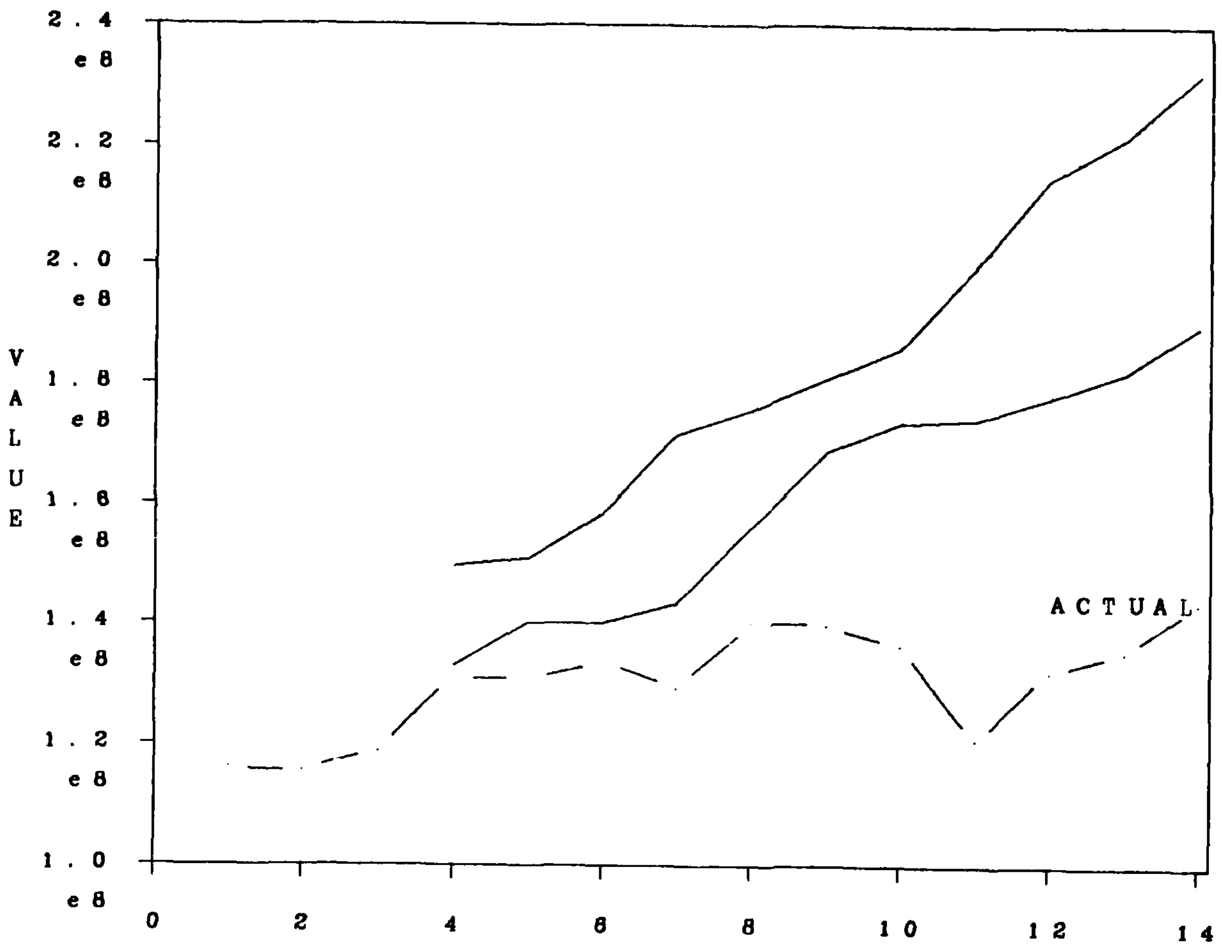
QUARTER NUMBER
95% Confidence Band of Simulation Results

SIMULATION RESULTS (FOURTH ITEM GROUPING)

ANNUAL DEMAND VALUE BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	303449	2862320	426733	4229799	7755712	130020544	145598560
	ACTUAL	7226	3865751	667380	3365566	8748398	114670864	131325184
83-1	SIM	169621	2084854	399543	3893051	7887541	131584864	146019472
	ACTUAL	113649	4061098	673067	3653195	8440463	113786432	130727912
83-2	SIM	144346	2037605	378937	3955672	7345137	129841888	143703584
	ACTUAL	34012	4509959	663035	3521649	8125791	116912320	133766768
83-3	SIM	139393	2238562	353679	3985839	7309093	136078448	150105008
	ACTUAL	47756	4685676	602095	3238073	8936554	112067296	129577456
83-4	SIM	180504	1844015	329082	4183976	7526030	145588304	159651920
	ACTUAL	4406	4173377	628858	3906527	8664319	122958128	140335616
84-1	SIM	159867	1993619	314097	4130907	7956447	156002896	170557840
	ACTUAL	117438	3856301	651863	3975632	9737451	121541248	139879936
84-2	SIM	203374	2265676	289591	4164017	7413213	164749600	179085472
	ACTUAL	3071	3783336	600674	3929928	10564282	117688640	136569936
84-3	SIM	201119	2030046	283449	4163283	7022633	170431344	184131872
	ACTUAL	113723	3324610	563628	3656849	11293825	101913840	120866480
84-4	SIM	206401	1986695	270844	4082710	7021428	182451600	196019680
	ACTUAL	7840	3623736	580906	4197255	10061051	113911288	132382080
85-1	SIM	187236	1890681	261068	4091090	7342517	186732992	200505584
	ACTUAL	205523	3540096	624354	4164228	9832823	117296720	135663744
85-2	SIM	181539	2232489	258768	3986071	7465154	191706864	205830896
	ACTUAL	166702	3252831	626310	4241083	10345486	125191104	143823520

ANNUAL DEMAND VALUE (RUN 4)



QUARTER NUMBER
Simulated versus Actual

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND FREQUENCY GROUP ITEM COUNTS

QUARTER	SOURCE	0	1-9	10-19	20-199	200-UP
82-4	SIMULATED	24571	11612	2356	1933	437
	ACTUAL	24361	12980	1290	1829	449
	% DIFFERENCE	0.86	-10.54	82.64	5.69	-2.67
83-1	SIMULATED	27225	9093	2164	1996	431
	ACTUAL	23203	14096	1312	1841	457
	% DIFFERENCE	17.33	-35.49	64.94	8.42	-5.69
83-2	SIMULATED	28134	8014	2213	2124	424
	ACTUAL	23361	13866	1337	1880	465
	% DIFFERENCE	20.43	-42.20	65.52	12.98	-8.82
83-3	SIMULATED	28387	7632	2186	2280	424
	ACTUAL	22754	14375	1374	1925	481
	% DIFFERENCE	24.76	-46.91	59.10	18.44	-11.85
83-4	SIMULATED	28192	7623	2219	2449	426
	ACTUAL	23577	13581	1341	1929	481
	% DIFFERENCE	19.57	-43.87	65.47	26.96	-11.43
84-1	SIMULATED	27863	7870	2179	2565	432
	ACTUAL	23668	13452	1370	1933	486
	% DIFFERENCE	17.72	-41.50	59.05	32.70	-11.11
84-2	SIMULATED	27621	8044	2065	2748	431
	ACTUAL	24465	12703	1362	1909	470
	% DIFFERENCE	12.90	-36.68	51.62	43.95	-8.30
84-3	SIMULATED	27400	8199	1984	2894	432
	ACTUAL	24548	12596	1398	1897	470
	% DIFFERENCE	11.62	-34.91	41.92	52.56	-8.09
84-4	SIMULATED	27224	8300	1933	3011	441
	ACTUAL	25093	12076	1403	1875	462
	% DIFFERENCE	8.49	-31.27	37.78	60.59	-4.55
85-1	SIMULATED	27109	8354	1859	3142	445
	ACTUAL	25060	12145	1380	1869	455
	% DIFFERENCE	8.18	-31.21	34.71	68.11	-2.20
85-2	SIMULATED	26999	8405	1801	3254	450
	ACTUAL	25664	11564	1380	1865	436
	% DIFFERENCE	5.20	-27.32	30.51	74.48	3.21

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY ITEM COUNT SUMMARY

QUARTER		N-S	NSO	R/L	R/M	R/H1	R/H2
82-4	SIMULATED	5665	28271	2423	2237	809	1504
	ACTUAL	9259	24281	3338	1862	724	1445
83-1	SIMULATED	5642	28142	2480	2252	804	1588
	ACTUAL	7549	25791	3536	1847	685	1501
83-2	SIMULATED	5623	28016	2481	2309	748	1728
	ACTUAL	8510	24740	3548	1862	668	1581
83-3	SIMULATED	5600	27899	2507	2309	739	1849
	ACTUAL	8833	24369	3496	1870	741	1600
83-4	SIMULATED	5584	28620	1962	2094	712	1928
	ACTUAL	9292	23884	3552	1871	702	1608
84-1	SIMULATED	5553	28638	1880	2100	727	2002
	ACTUAL	9624	23204	3864	1931	764	1522
84-2	SIMULATED	5522	28655	1827	2087	699	2108
	ACTUAL	9805	23360	3567	1957	794	1426
84-3	SIMULATED	5491	28627	1774	2092	694	2220
	ACTUAL	9810	23316	3567	2012	907	1297
84-4	SIMULATED	5460	28615	1754	2065	697	2306
	ACTUAL	10940	22261	3503	2057	783	1365
85-1	SIMULATED	5429	28635	1685	2060	697	2391
	ACTUAL	10945	21959	3724	2123	784	1374
85-2	SIMULATED	5402	28639	1629	2054	703	2470
	ACTUAL	11085	21605	3934	2165	785	1335

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4

	FROM	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
					TO			
SIMULATED	N-S	5665	0	91	58	11	3	5828
ACTUAL		6190	38	9	4	3	0	6244
SIMULATED	NSO	0	26919	801	626	123	62	28531
ACTUAL		2932	23890	269	140	19	16	27266
SIMULATED	R/L	0	1156	1472	474	11	1	3114
ACTUAL		105	279	2827	140	1	1	3353
SIMULATED	R/M	0	174	59	1063	305	53	1654
ACTUAL		27	63	232	1499	93	12	1926
SIMULATED	R/H1	0	15	0	13	239	447	714
ACTUAL		5	8	1	77	560	184	835
SIMULATED	R/H2	0	7	0	3	120	938	1068
ACTUAL		0	3	0	2	48	1232	1285

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4 (PERCENT)

	FROM	N-S	NSO	R/L	R/M	R/H1	R/H2
					TO		
SIMULATED	N-S	97.2032	0.0000	1.5614	0.9952	0.1887	0.0515
ACTUAL		99.1352	0.6086	0.1441	0.0641	0.0480	0.0000
SIMULATED	NSO	0.0000	94.3500	2.8075	2.1941	0.4311	0.2173
ACTUAL		10.7533	87.6183	0.9866	0.5135	0.0697	0.0587
SIMULATED	R/L	0.0000	37.1227	47.2704	15.2216	0.3532	0.0321
ACTUAL		3.1315	8.3209	84.3126	4.1754	0.0298	0.0298
SIMULATED	R/M	0.0000	10.5200	3.5671	64.2684	18.4401	3.2044
ACTUAL		1.4019	3.2710	12.0457	77.8297	4.8287	0.6231
SIMULATED	R/H1	0.0000	2.1008	0.0000	1.8207	33.4734	62.6050
ACTUAL		0.5988	0.9581	0.1198	9.2216	67.0659	22.0359
SIMULATED	R/H2	0.0000	0.6554	0.0000	0.2809	11.2360	87.8277
ACTUAL		0.0000	0.2335	0.0000	0.1556	3.7354	95.8755

TOTAL SQUARED DIFFERENCE = 0.596206

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5642	0	13	9	1	0	5665
ACTUAL		6237	2845	133	32	9	3	9259
SIMULATED	NSO	0	27931	199	120	16	5	28271
ACTUAL		1259	22546	295	143	24	14	24281
SIMULATED	R/L	0	144	2142	134	1	2	2423
ACTUAL		21	325	2847	144	1	0	3338
SIMULATED	R/M	0	51	126	1933	113	13	2236
ACTUAL		16	68	259	1442	72	5	1862
SIMULATED	R/H1	0	14	0	56	581	158	809
ACTUAL		5	7	2	83	497	130	724
SIMULATED	R/H2	0	2	0	0	92	1410	1504
ACTUAL		11	0	0	3	82	1349	1445

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.5940	0.0000	0.2295	0.1589	0.0177	0.0000
ACTUAL		67.3615	30.7269	1.4364	0.3456	0.0972	0.0324
SIMULATED	NSO	0.0000	98.7974	0.7039	0.4245	0.0566	0.0177
ACTUAL		5.1851	92.8545	1.2149	0.5889	0.0988	0.0577
SIMULATED	R/L	0.0000	5.9430	88.4028	5.5303	0.0413	0.0825
ACTUAL		0.6291	9.7364	85.2906	4.3140	0.0300	0.0000
SIMULATED	R/M	0.0000	2.2809	5.6351	86.4490	5.0537	0.5814
ACTUAL		0.8593	3.6520	13.9098	77.4436	3.8668	0.2685
SIMULATED	R/H1	0.0000	1.7305	0.0000	6.9221	71.8171	19.5303
ACTUAL		0.6906	0.9669	0.2762	11.4641	68.6464	17.9558
SIMULATED	R/H2	0.0000	0.1330	0.0000	0.0000	6.1170	93.7500
ACTUAL		0.7612	0.0000	0.0000	0.2076	5.6747	93.3564

TOTAL SQUARED DIFFERENCE = 0.226201

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5623	0	10	9	0	0	5642
ACTUAL		7376	115	23	11	4	20	7549
SIMULATED	NSO	0	27824	170	115	17	13	28139
ACTUAL		1110	24225	280	136	24	16	25791
SIMULATED	R/L	0	127	2225	127	0	1	2480
ACTUAL		16	326	3024	166	0	4	3536
SIMULATED	R/M	0	52	75	2011	105	9	2252
ACTUAL		6	61	220	1462	90	8	1847
SIMULATED	R/H1	0	10	1	47	537	209	804
ACTUAL		2	7	1	87	476	112	685
SIMULATED	R/H2	0	3	0	0	89	1496	1588
ACTUAL		0	6	0	0	74	1421	1501

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.6632	0.0000	0.1772	0.1595	0.0000	0.0000
ACTUAL		97.7083	1.5234	0.3047	0.1457	0.0530	0.2649
SIMULATED	NSO	0.0000	98.8806	0.6041	0.4087	0.0604	0.0462
ACTUAL		4.3038	93.9281	1.0856	0.5273	0.0931	0.0620
SIMULATED	R/L	0.0000	5.1210	89.7177	5.1210	0.0000	0.0403
ACTUAL		0.4525	9.2195	85.5204	4.6946	0.0000	0.1131
SIMULATED	R/M	0.0000	2.3091	3.3304	89.2984	4.6625	0.3996
ACTUAL		0.3249	3.3027	11.9112	79.1554	4.8728	0.4331
SIMULATED	R/H1	0.0000	1.2438	0.1244	5.8458	66.7910	25.9950
ACTUAL		0.2920	1.0219	0.1460	12.7007	69.4890	16.3504
SIMULATED	R/H2	0.0000	0.1889	0.0000	0.0000	5.6045	94.2065
ACTUAL		0.0000	0.3997	0.0000	0.0000	4.9300	94.6702

TOTAL SQUARED DIFFERENCE = 0.041012

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5600	0	12	9	2	0	5623
ACTUAL		8312	170	8	7	5	8	8510
SIMULATED	NSO	0	27735	161	92	21	5	28014
ACTUAL		508	23766	269	155	28	14	24740
SIMULATED	R/L	0	124	2258	98	1	0	2481
ACTUAL		13	353	2936	236	6	4	3548
SIMULATED	R/M	0	34	76	2073	119	7	2309
ACTUAL		0	67	281	1393	110	11	1862
SIMULATED	R/H1	0	4	0	37	518	189	748
ACTUAL		0	10	1	77	453	127	668
SIMULATED	R/H2	0	2	0	0	78	1648	1728
ACTUAL		0	3	1	2	139	1436	1581

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.5910	0.0000	0.2134	0.1601	0.0356	0.0000
ACTUAL		97.6733	1.9976	0.0940	0.0823	0.0588	0.0940
SIMULATED	NSO	0.0000	99.0041	0.5747	0.3284	0.0750	0.0178
ACTUAL		2.0534	96.0631	1.0873	0.6265	0.1132	0.0566
SIMULATED	R/L	0.0000	4.9980	91.0117	3.9500	0.0403	0.0000
ACTUAL		0.3664	9.9493	82.7508	6.6516	0.1691	0.1127
SIMULATED	R/M	0.0000	1.4725	3.2915	89.7791	5.1537	0.3032
ACTUAL		0.0000	3.5983	15.0913	74.8120	5.9076	0.5908
SIMULATED	R/H1	0.0000	0.5348	0.0000	4.9465	69.2513	25.2674
ACTUAL		0.0000	1.4970	0.1497	11.5269	67.8144	19.0120
SIMULATED	R/H2	0.0000	0.1157	0.0000	0.0000	4.5139	95.3704
ACTUAL		0.0000	0.1898	0.0633	0.1265	8.7919	90.8286

TOTAL SQUARED DIFFERENCE = 0.061396

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5584	0	10	5	1	0	5600
ACTUAL		8692	130	8	2	1	0	8833
SIMULATED	NSO	0	27635	161	78	17	5	27896
ACTUAL		554	23398	274	113	23	7	24369
SIMULATED	R/L	0	663	1737	106	0	1	2507
ACTUAL		28	298	3006	162	2	0	3496
SIMULATED	R/M	0	281	54	1863	106	5	2309
ACTUAL		12	50	263	1482	63	0	1870
SIMULATED	R/H1	0	29	0	42	505	163	739
ACTUAL		3	7	0	107	518	106	741
SIMULATED	R/H2	0	12	0	0	83	1754	1849
ACTUAL		3	1	1	5	95	1495	1600

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.7143	0.0000	0.1786	0.0893	0.0179	0.0000
ACTUAL		98.4037	1.4718	0.0906	0.0226	0.0113	0.0000
SIMULATED	NSO	0.0000	99.0644	0.5771	0.2796	0.0609	0.0179
ACTUAL		2.2734	96.0154	1.1244	0.4637	0.0944	0.0287
SIMULATED	R/L	0.0000	26.4460	69.2860	4.2282	0.0000	0.0399
ACTUAL		0.8009	8.5240	85.9840	4.6339	0.0572	0.0000
SIMULATED	R/M	0.0000	12.1698	2.3387	80.6843	4.5907	0.2165
ACTUAL		0.6417	2.6738	14.0642	79.2513	3.3690	0.0000
SIMULATED	R/H1	0.0000	3.9242	0.0000	5.6834	68.3356	22.0568
ACTUAL		0.4049	0.9447	0.0000	14.4399	69.9055	14.3050
SIMULATED	R/H2	0.0000	0.6490	0.0000	0.0000	4.4889	94.8621
ACTUAL		0.1875	0.0625	0.0625	0.3125	5.9375	93.4375

TOTAL SQUARED DIFFERENCE = 0.100407

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5553	0	21	7	1	2	5584
ACTUAL		9136	143	9	4	0	0	9292
SIMULATED	NSO	0	28362	142	94	20	2	28620
ACTUAL		448	23010	267	128	26	5	23884
SIMULATED	R/L	0	206	1663	92	0	1	1962
ACTUAL		21	25	3352	154	0	0	3552
SIMULATED	R/M	0	60	54	1878	97	5	2094
ACTUAL		8	20	235	1528	78	2	1871
SIMULATED	R/H1	0	8	0	29	518	157	712
ACTUAL		4	4	1	114	521	58	702
SIMULATED	R/H2	0	2	0	0	91	1835	1928
ACTUAL		7	2	0	3	139	1457	1608

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.4448	0.0000	0.3761	0.1254	0.0179	0.0358
ACTUAL		98.3211	1.5390	0.0969	0.0430	0.0000	0.0000
SIMULATED	NSO	0.0000	99.0985	0.4962	0.3284	0.0699	0.0070
ACTUAL		1.8757	96.3406	1.1179	0.5359	0.1089	0.0209
SIMULATED	R/L	0.0000	10.4995	84.7605	4.6891	0.0000	0.0510
ACTUAL		0.5912	0.7038	94.3694	4.3356	0.0000	0.0000
SIMULATED	R/M	0.0000	2.8653	2.5788	89.6848	4.6323	0.2388
ACTUAL		0.4276	1.0689	12.5601	81.6676	4.1689	0.1069
SIMULATED	R/H1	0.0000	1.1236	0.0000	4.0730	72.7528	22.0506
ACTUAL		0.5698	0.5698	0.1425	16.2393	74.2165	8.2621
SIMULATED	R/H2	0.0000	0.1037	0.0000	0.0000	4.7199	95.1764
ACTUAL		0.4353	0.1244	0.0000	0.1866	8.6443	90.6095

TOTAL SQUARED DIFFERENCE = 0.074900

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5522	0	21	9	1	0	5553
ACTUAL		8587	1012	20	4	0	1	9624
SIMULATED	NSO	0	28352	169	91	18	6	28636
ACTUAL		1171	21671	217	117	22	6	23204
SIMULATED	R/L	0	209	1590	80	1	0	1880
ACTUAL		30	557	3100	174	3	0	3864
SIMULATED	R/M	0	82	47	1867	91	13	2100
ACTUAL		8	102	229	1526	63	3	1931
SIMULATED	R/H1	0	8	0	40	515	164	727
ACTUAL		2	12	1	131	552	66	764
SIMULATED	R/H2	0	4	0	0	73	1925	2002
ACTUAL		7	6	0	5	154	1350	1522

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.4417	0.0000	0.3782	0.1621	0.0180	0.0000
ACTUAL		89.2249	10.5154	0.2078	0.0416	0.0000	0.0104
SIMULATED	NSO	0.0000	99.0082	0.5902	0.3178	0.0629	0.0210
ACTUAL		5.0465	93.3934	0.9352	0.5042	0.0948	0.0259
SIMULATED	R/L	0.0000	11.1170	84.5745	4.2553	0.0532	0.0000
ACTUAL		0.7764	14.4151	80.2277	4.5031	0.0776	0.0000
SIMULATED	R/M	0.0000	3.9048	2.2381	88.9048	4.3333	0.6190
ACTUAL		0.4143	5.2822	11.8591	79.0264	3.2626	0.1554
SIMULATED	R/H1	0.0000	1.1004	0.0000	5.5021	70.8391	22.5585
ACTUAL		0.2618	1.5707	0.1309	17.1466	72.2513	8.6387
SIMULATED	R/H2	0.0000	0.1998	0.0000	0.0000	3.6464	96.1538
ACTUAL		0.4599	0.3942	0.0000	0.3285	10.1183	88.6991

TOTAL SQUARED DIFFERENCE = 0.092564

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5491	0	22	7	0	2	5522
ACTUAL		9659	136	7	1	1	1	9805
SIMULATED	NSO	0	28366	159	95	24	11	28655
ACTUAL		109	22822	249	148	24	8	23360
SIMULATED	R/L	0	198	1538	88	2	1	1827
ACTUAL		19	275	3049	221	3	0	3567
SIMULATED	R/M	0	55	55	1868	104	5	2087
ACTUAL		10	72	258	1500	105	12	1957
SIMULATED	R/H1	0	4	0	34	484	177	699
ACTUAL		5	9	3	133	564	80	794
SIMULATED	R/H2	0	4	0	0	80	2024	2108
ACTUAL		8	2	1	9	210	1196	1426

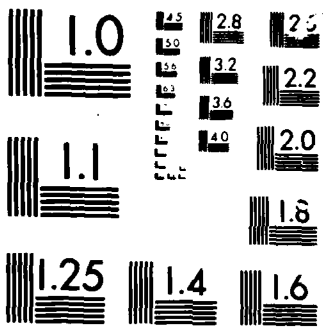
DEMAND CATEGORY MIGRATION FOR QUARTER 84-3 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.4386	0.0000	0.3984	0.1268	0.0000	0.0362
ACTUAL		98.5110	1.3870	0.0714	0.0102	0.0102	0.0102
SIMULATED	NSO	0.0000	98.9914	0.5549	0.3315	0.0838	0.0384
ACTUAL		0.4666	97.6969	1.0659	0.6336	0.1027	0.0342
SIMULATED	R/L	0.0000	10.8374	84.1817	4.8166	0.1095	0.0547
ACTUAL		0.5327	7.7096	85.4780	6.1957	0.0841	0.0000
SIMULATED	R/M	0.0000	2.6354	2.6354	89.5065	4.9832	0.2396
ACTUAL		0.5110	3.6791	13.1834	76.6479	5.3654	0.6132
SIMULATED	R/H1	0.0000	0.5722	0.0000	4.8641	69.2418	25.3219
ACTUAL		0.6297	1.1335	0.3778	16.7506	71.0327	10.0756
SIMULATED	R/H2	0.0000	0.1898	0.0000	0.0000	3.7951	96.0152
ACTUAL		0.5610	0.1403	0.0701	0.6311	14.7265	83.8710

TOTAL SQUARED DIFFERENCE = 0.094255

AD-A167 126 ESTIMATION OF INVENTORY ITEM DEMAND DISTRIBUTIONS: MODELING ITEM MIGRATIO..(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH K P SMITH DEC 85 4/4

UNCLASSIFIED AFIT/GOR/OS/85S-18 F/G 15/5 NL



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SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5460	0	20	9	2	0	5491
ACTUAL		9773	34	2	1	0	0	9810
SIMULATED	NSO	0	28374	160	79	10	3	28626
ACTUAL		1124	21805	224	142	13	8	23316
SIMULATED	R/L	0	173	1521	80	0	0	1774
ACTUAL		24	313	3055	174	1	0	3567
SIMULATED	R/M	0	61	53	1873	97	8	2092
ACTUAL		11	83	219	1617	72	10	2012
SIMULATED	R/H1	0	7	0	24	504	159	694
ACTUAL		2	19	3	120	621	142	907
SIMULATED	R/H2	0	0	0	0	84	2136	2220
ACTUAL		6	7	0	3	76	1205	1297

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.4354	0.0000	0.3642	0.1639	0.0364	0.0000
ACTUAL		99.6228	0.3466	0.0204	0.0102	0.0000	0.0000
SIMULATED	NSO	0.0000	99.1197	0.5589	0.2760	0.0349	0.0105
ACTUAL		4.8207	93.5195	0.9607	0.6090	0.0558	0.0343
SIMULATED	R/L	0.0000	9.7520	85.7384	4.5096	0.0000	0.0000
ACTUAL		0.6728	8.7749	85.6462	4.8780	0.0280	0.0000
SIMULATED	R/M	0.0000	2.9159	2.5335	89.5315	4.6367	0.3824
ACTUAL		0.5467	4.1252	10.8847	80.3678	3.5785	0.4970
SIMULATED	R/H1	0.0000	1.0086	0.0000	3.4582	72.6225	22.9107
ACTUAL		0.2205	2.0948	0.3308	13.2304	68.4675	15.6560
SIMULATED	R/H2	0.0000	0.0000	0.0000	0.0000	3.7838	96.2162
ACTUAL		0.4626	0.5397	0.0000	0.2313	5.8597	92.9067

TOTAL SQUARED DIFFERENCE = 0.039589

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5429	0	13	13	5	0	5460
ACTUAL		10781	136	14	6	3	0	10940
SIMULATED	NSO	0	28387	130	82	11	5	28615
ACTUAL		114	21786	210	133	15	3	22261
SIMULATED	R/L	0	189	1493	71	0	1	1754
ACTUAL		25	18	3262	196	2	0	3503
SIMULATED	R/M	0	52	49	1863	92	9	2065
ACTUAL		13	16	236	1677	110	5	2057
SIMULATED	R/H1	0	4	0	31	511	151	697
ACTUAL		3	1	1	108	539	131	783
SIMULATED	R/H2	0	3	0	0	78	2225	2306
ACTUAL		9	2	1	3	115	1235	1365

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.4322	0.0000	0.2381	0.2381	0.0916	0.0000
ACTUAL		98.5466	1.2431	0.1280	0.0548	0.0274	0.0000
SIMULATED	NSO	0.0000	99.2032	0.4543	0.2866	0.0384	0.0175
ACTUAL		0.5121	97.8662	0.9434	0.5975	0.0674	0.0135
SIMULATED	R/L	0.0000	10.7754	85.1197	4.0479	0.0000	0.0570
ACTUAL		0.7137	0.5138	93.1202	5.5952	0.0571	0.0000
SIMULATED	R/M	0.0000	2.5182	2.3729	90.2179	4.4552	0.4358
ACTUAL		0.6320	0.7778	11.4730	81.5265	5.3476	0.2431
SIMULATED	R/H1	0.0000	0.5739	0.0000	4.4476	73.3142	21.6643
ACTUAL		0.3831	0.1277	0.1277	13.7931	68.8378	16.7305
SIMULATED	R/H2	0.0000	0.1301	0.0000	0.0000	3.3825	96.4874
ACTUAL		0.6593	0.1465	0.0733	0.2198	8.4249	90.4762

TOTAL SQUARED DIFFERENCE = 0.053373

SIMULATION RESULTS (FOURTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2

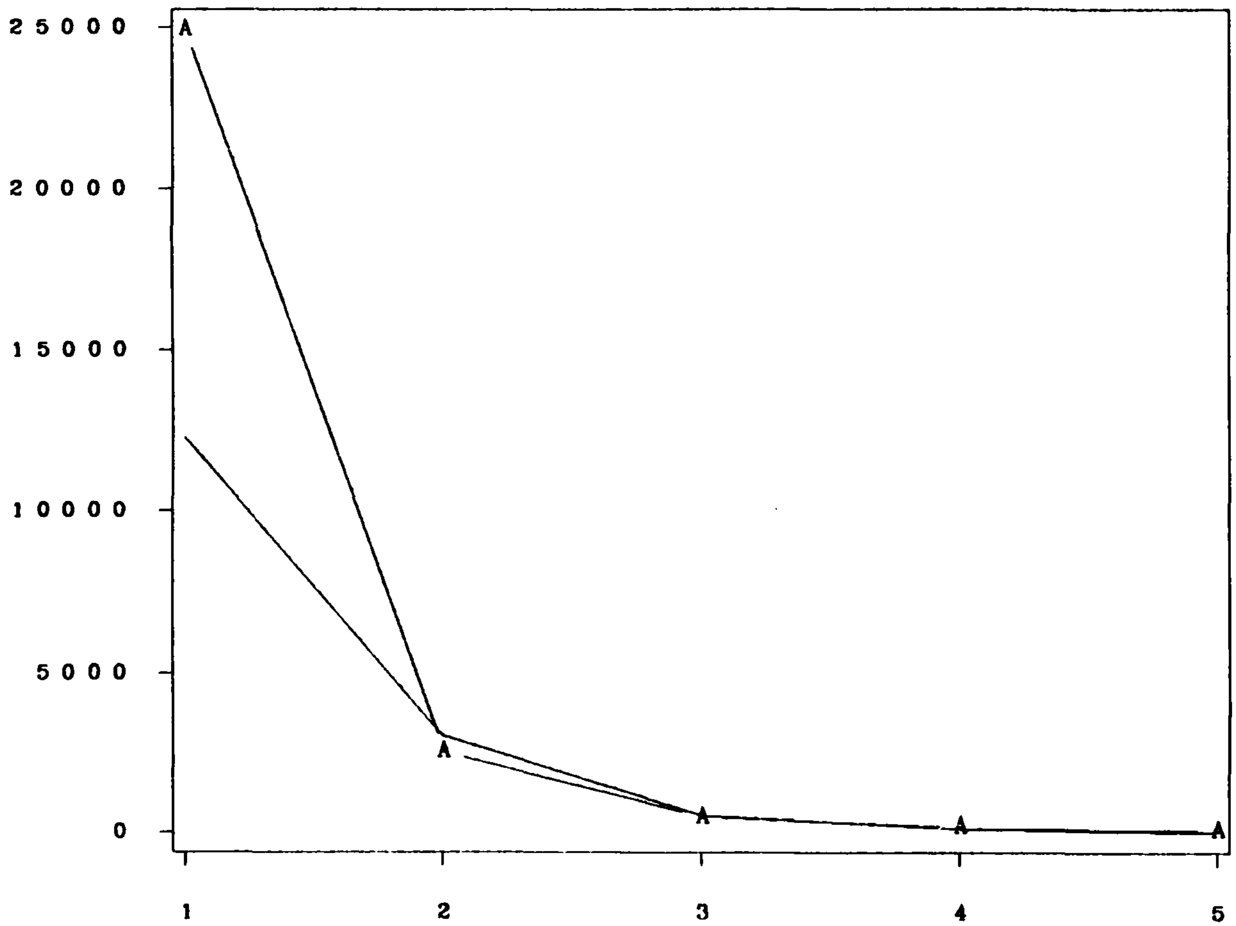
	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5402	0	13	12	2	0	5429
ACTUAL		10747	182	11	2	1	2	10945
SIMULATED	NSO	0	28373	160	82	16	4	28635
ACTUAL		271	21363	175	121	24	5	21959
SIMULATED	R/L	0	204	1409	72	0	0	1685
ACTUAL		41	31	3486	165	1	0	3724
SIMULATED	R/M	0	52	47	1865	82	14	2060
ACTUAL		14	26	261	1735	80	7	2123
SIMULATED	R/H1	0	6	0	23	509	159	697
ACTUAL		4	2	1	139	553	85	784
SIMULATED	R/H2	0	4	0	0	94	2293	2391
ACTUAL		8	1	0	3	126	1236	1374

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.5027	0.0000	0.2395	0.2210	0.0368	0.0000
ACTUAL		98.1910	1.6629	0.1005	0.0183	0.0091	0.0183
SIMULATED	NSO	0.0000	99.0850	0.5588	0.2864	0.0559	0.0140
ACTUAL		1.2341	97.2858	0.7969	0.5510	0.1093	0.0228
SIMULATED	R/L	0.0000	12.1068	83.6202	4.2730	0.0000	0.0000
ACTUAL		1.1010	0.8324	93.6090	4.4307	0.0269	0.0000
SIMULATED	R/M	0.0000	2.5243	2.2816	90.5340	3.9806	0.6796
ACTUAL		0.6594	1.2247	12.2939	81.7240	3.7683	0.3297
SIMULATED	R/H1	0.0000	0.8608	0.0000	3.2999	73.0273	22.8121
ACTUAL		0.5102	0.2551	0.1276	17.7296	70.5357	10.8418
SIMULATED	R/H2	0.0000	0.1673	0.0000	0.0000	3.9314	95.9013
ACTUAL		0.5822	0.0728	0.0000	0.2183	9.1703	89.9563

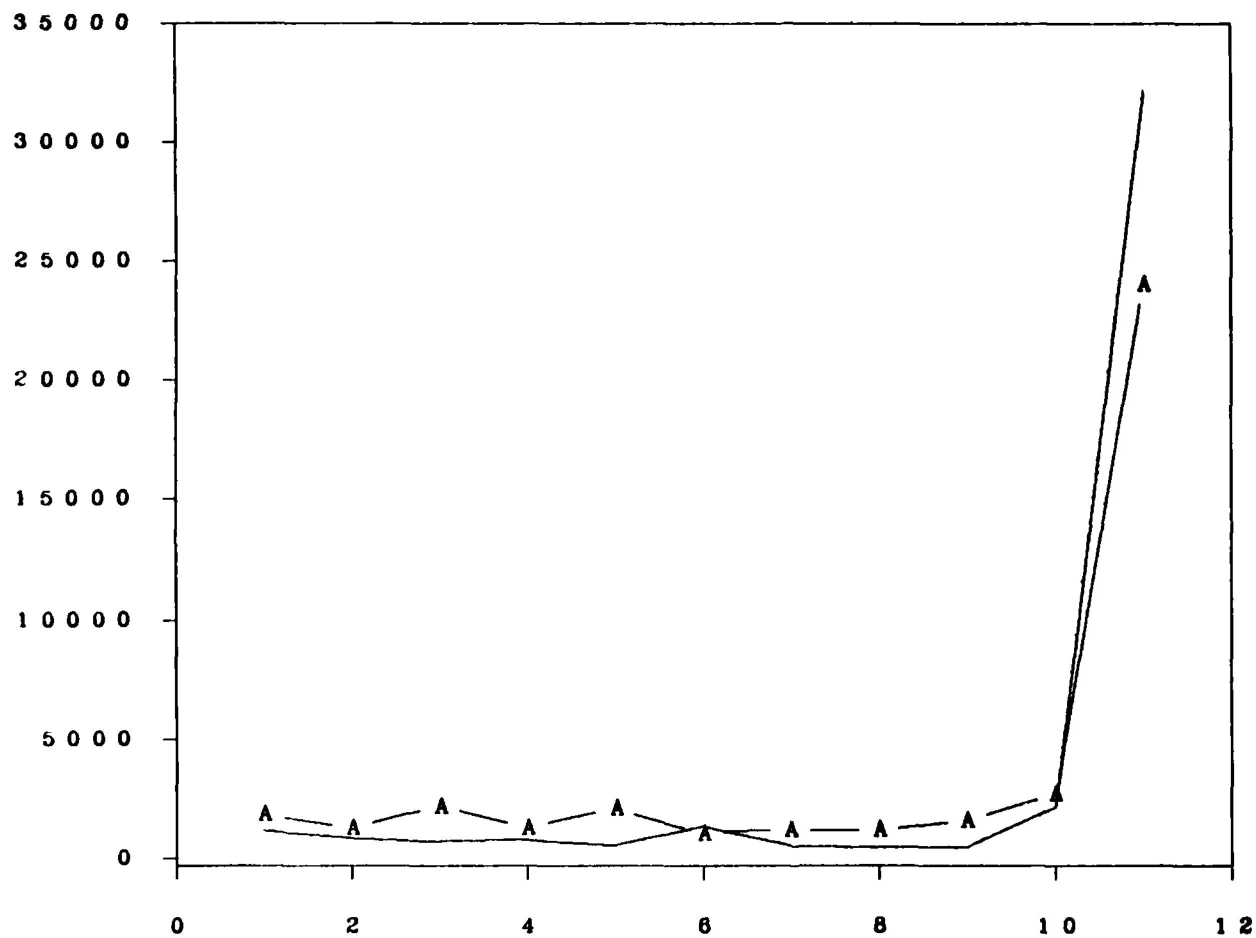
TOTAL SQUARED DIFFERENCE = 0.083926

DEMAND CATEGORY MIGRATION JUMP SIZE (RUN 4)



SIZE OF JUMP
Simulated versus (A)ctual

DEMAND CATEGORY STABILITY (RUN 4)



QUARTERS IN SAME DEMAND CATEGORY

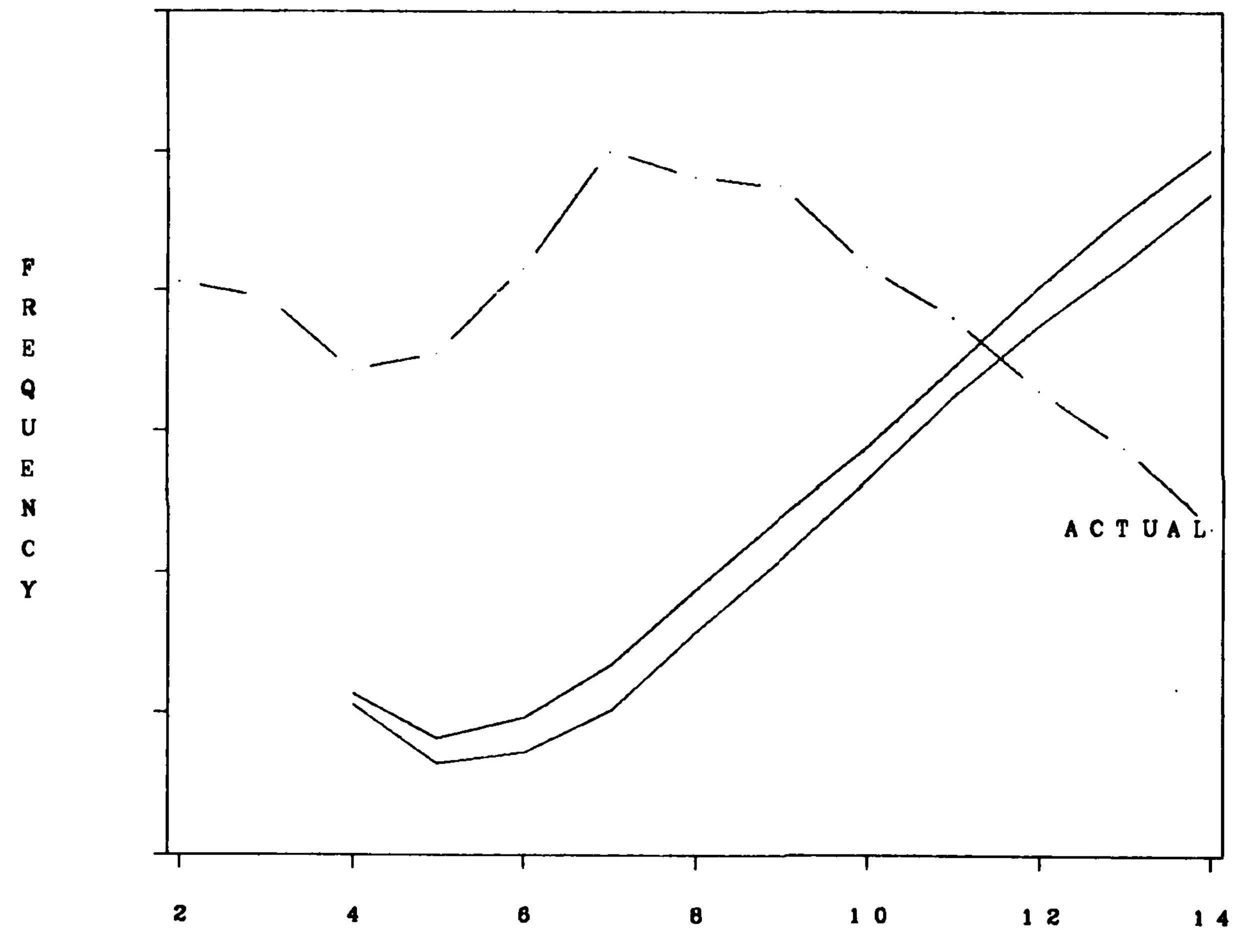
Simulated versus (A)ctual

SIMULATION RESULTS (FIFTH ITEM GROUPING)

ANNUAL DEMAND FREQUENCY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	3141	30891	32446	60015	59461	175792	361746
	ACTUAL	78	19879	25687	40235	65799	256901	408579
83-1	SIM	2161	24379	32087	62338	58688	173524	353177
	ACTUAL	523	20752	26565	40575	65603	257019	411037
83-2	SIM	1853	20546	33976	67073	60402	172933	356783
	ACTUAL	244	20916	24552	42285	65482	269867	423346
83-3	SIM	1868	17381	35631	70920	62740	175900	364440
	ACTUAL	378	21392	25299	43315	72383	277079	439846
83-4	SIM	1961	18778	35752	74316	64596	179253	374656
	ACTUAL	38	20309	26144	42729	65419	281619	436258
84-1	SIM	2140	17797	37866	74980	71488	182265	386536
	ACTUAL	843	19539	26732	44342	69344	274278	435078
84-2	SIM	2281	17599	39166	81350	68192	188237	396825
	ACTUAL	42	18831	27085	44721	70552	262244	423475
84-3	SIM	2253	17765	42093	85764	70501	189614	407990
	ACTUAL	882	18011	26894	42785	77912	249815	416299
84-4	SIM	2302	18010	42806	87638	75187	192654	418597
	ACTUAL	120	17533	24814	44282	66554	252540	405843
85-1	SIM	2418	18382	43956	90972	76927	196287	428942
	ACTUAL	1580	16593	24378	42753	63021	249382	397707
85-2	SIM	2506	18730	45601	93575	77759	199365	437536
	ACTUAL	349	15816	23933	43458	61926	240759	386241

ANNUAL DEMAND FREQUENCY (RUN 5)



QUARTER NUMBER

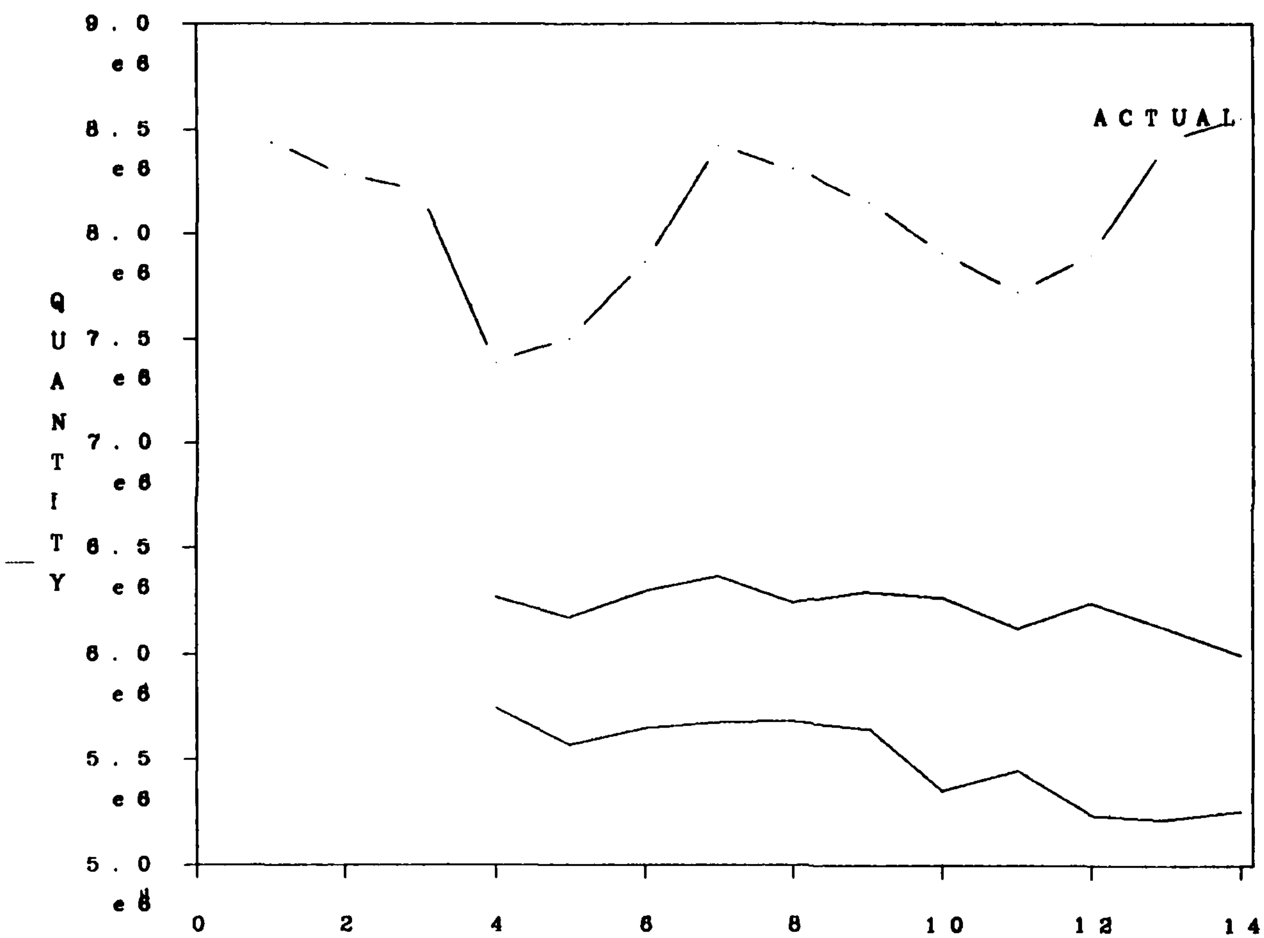
95% Confidence Band of Simulation Results

SIMULATION RESULTS (FIFTH ITEM GROUPING)

ANNUAL DEMAND QUANTITY BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	4690	51464	215963	876360	830827	4055932	6035236
	ACTUAL	1090	74105	254189	696862	2525225	3834572	7386043
83-1	SIM	2866	91198	200150	912881	651054	4115000	5973149
	ACTUAL	6364	75480	281169	661749	2648512	3825588	7498862
83-2	SIM	2418	60015	219023	908685	800761	4250036	6240938
	ACTUAL	3335	82093	226958	696557	2851641	4001940	7862524
83-3	SIM	2443	29878	210874	913670	748979	4347528	6253372
	ACTUAL	2228	90294	221293	695443	3408829	3998903	8416990
83-4	SIM	2558	53351	193129	868060	791510	4106553	6015161
	ACTUAL	127	83073	226318	678483	3207862	4110384	8306247
84-1	SIM	2813	27107	200066	793930	959719	4147603	6131238
	ACTUAL	8961	79011	235355	722681	3158481	3940969	8145458
84-2	SIM	3033	27983	186504	829838	950031	3932699	5930088
	ACTUAL	217	72123	258252	685591	3051590	3838691	7906464
84-3	SIM	2908	27089	193312	870844	830684	4004981	5929818
	ACTUAL	10430	60277	254606	655512	3075785	3665599	7722209
84-4	SIM	3009	30372	183936	781648	844944	4106857	5950766
	ACTUAL	603	60008	224907	682377	2997877	3930014	7895786
85-1	SIM	3202	30432	193265	801957	813244	4023355	5865455
	ACTUAL	15790	57358	227069	724197	3245093	4167927	8437434
85-2	SIM	3399	52695	197530	789503	770629	3976882	5790638
	ACTUAL	846	55751	231333	701261	3293255	4268149	8550595

ANNUAL DEMAND QUANTITY (RUN 5)



QUARTER NUMBER

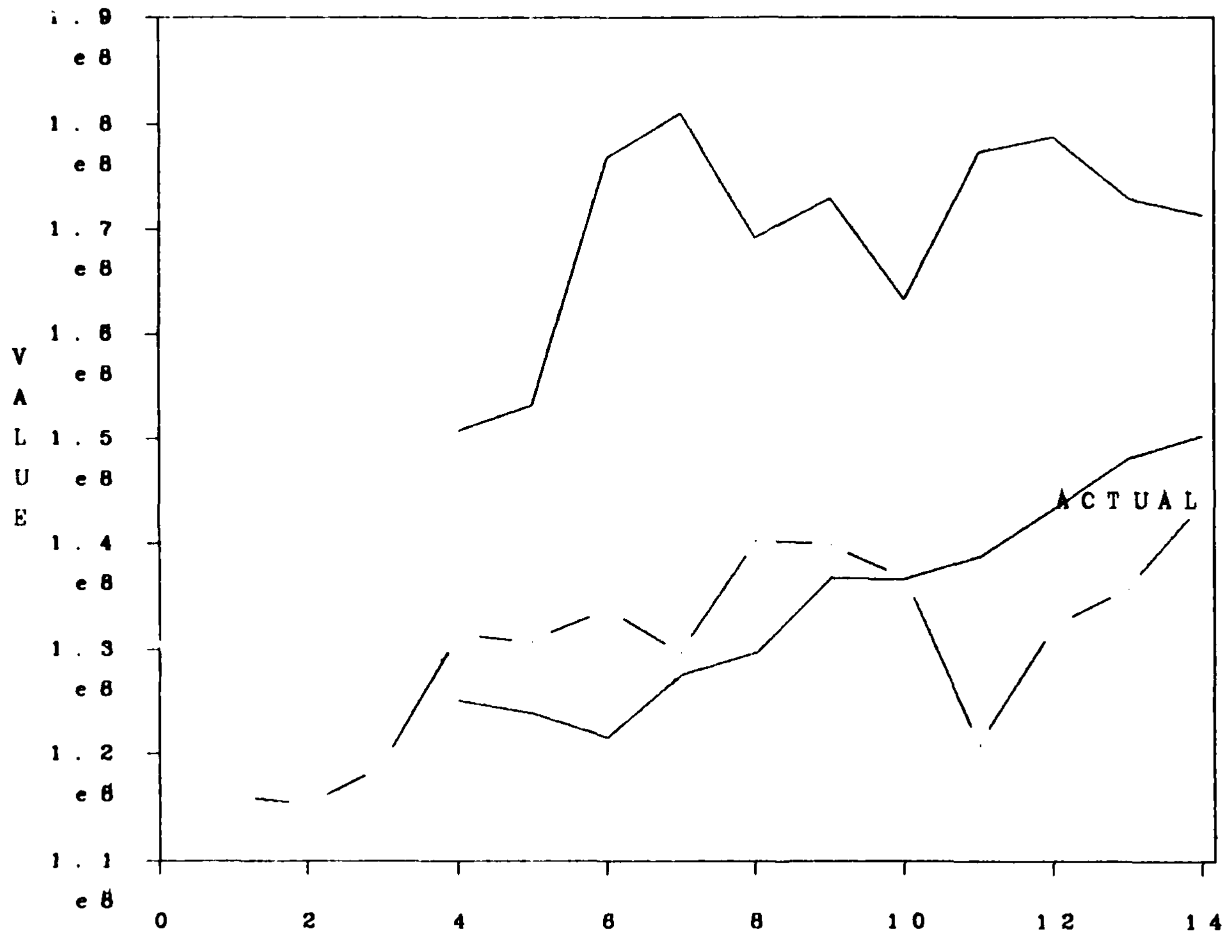
95% Confidence Band of Simulation Results

SIMULATION RESULTS (FIFTH ITEM GROUPING)

ANNUAL DEMAND VALUE BY MANAGEMENT CATEGORIES

QTR	SOURCE	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
82-4	SIM	245910	2959303	284342	3195766	7995667	126343824	141024816
	ACTUAL	7226	3865751	667380	3365566	8748398	114670864	131325184
83-1	SIM	139226	2176588	270682	3105336	7687405	133437832	146817072
	ACTUAL	113649	4061098	673067	3653195	8440463	113786432	130727912
83-2	SIM	113575	1837013	260299	3234017	7862513	157103856	170411280
	ACTUAL	34012	4509959	663035	3521649	8125791	116912320	133766768
83-3	SIM	81885	1614948	253836	3278945	7815456	160391520	173436592
	ACTUAL	47756	4685676	602095	3238073	8936554	112067296	129577456
83-4	SIM	84216	1433180	239112	3130962	7800570	149402304	162090352
	ACTUAL	4406	4173377	628858	3906527	8664319	122958128	140335616
84-1	SIM	101861	1562625	233702	3068640	8349813	150408336	163724976
	ACTUAL	117438	3856301	651863	3975632	9737451	121541248	139879936
84-2	SIM	105873	1496989	228388	3177060	7895064	132024648	144928032
	ACTUAL	3071	3783336	600674	3929928	10564282	117688640	136569936
84-3	SIM	111299	1440476	226137	3251242	8181688	134181168	147392016
	ACTUAL	113723	3324610	563628	3656849	11293825	101913840	120866480
84-4	SIM	134400	1566060	223415	3307652	8279230	136523600	150034368
	ACTUAL	7840	3623736	580906	4197255	10061051	113911288	132382080
85-1	SIM	145115	1641100	218539	3306803	8445272	142029168	155786000
	ACTUAL	205523	3540096	624354	4164228	9832823	117296720	135663744
85-2	SIM	164332	1734976	215527	3254984	8511770	144305920	158187504
	ACTUAL	166702	3252831	626310	4241083	10345486	125191104	143823520

ANNUAL DEMAND VALUE (RUN 5)



QUARTER NUMBER
Simulated versus Actual

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND FREQUENCY GROUP ITEM COUNTS

QUARTER	SOURCE	0	1-9	10-19	20-199	200-UP
82-4	SIMULATED	24352	11854	2379	1913	411
	ACTUAL	24361	12980	1290	1829	449
	% DIFFERENCE	-0.04	-8.67	84.42	4.59	-8.46
83-1	SIMULATED	27323	9089	2110	1976	411
	ACTUAL	23203	14096	1312	1841	457
	% DIFFERENCE	17.76	-35.52	60.82	7.33	-10.07
83-2	SIMULATED	28582	7760	2019	2136	412
	ACTUAL	23361	13866	1337	1880	465
	% DIFFERENCE	22.35	-44.04	51.01	13.62	-11.40
83-3	SIMULATED	28922	7330	1863	2381	413
	ACTUAL	22754	14375	1374	1925	481
	% DIFFERENCE	27.11	-49.01	35.59	23.69	-14.14
83-4	SIMULATED	28982	7206	1718	2590	413
	ACTUAL	23577	13581	1341	1929	481
	% DIFFERENCE	22.92	-46.94	28.11	34.27	-14.14
84-1	SIMULATED	28540	7587	1623	2746	413
	ACTUAL	23668	13452	1370	1933	486
	% DIFFERENCE	20.58	-43.60	18.47	42.06	-15.02
84-2	SIMULATED	28282	7803	1476	2935	413
	ACTUAL	24465	12703	1362	1909	470
	% DIFFERENCE	15.60	-38.57	8.37	53.75	-12.13
84-3	SIMULATED	27982	8049	1386	3079	413
	ACTUAL	24548	12596	1398	1897	470
	% DIFFERENCE	13.99	-36.10	-0.86	62.31	-12.13
84-4	SIMULATED	27752	8198	1341	3205	413
	ACTUAL	25093	12076	1403	1875	462
	% DIFFERENCE	10.60	-32.11	-4.42	70.93	-10.61
85-1	SIMULATED	27615	8314	1230	3337	413
	ACTUAL	25060	12145	1380	1869	455
	% DIFFERENCE	10.20	-31.54	-10.87	78.54	-9.23
85-2	SIMULATED	27325	8541	1156	3474	413
	ACTUAL	25664	11564	1380	1865	436
	% DIFFERENCE	6.47	-26.14	-16.23	86.27	-5.28

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY ITEM COUNT SUMMARY

QUARTER		N-S	NSO	R/L	R/M	R/H1	R/H2
82-4	SIMULATED	5754	29744	1737	1776	819	1079
	ACTUAL	9259	24281	3338	1862	724	1445
83-1	SIMULATED	5746	29725	1735	1782	821	1100
	ACTUAL	7549	25791	3536	1847	685	1501
83-2	SIMULATED	5739	29583	1773	1867	826	1121
	ACTUAL	8510	24740	3548	1862	668	1581
83-3	SIMULATED	5726	29476	1813	1907	830	1157
	ACTUAL	8833	24369	3496	1870	741	1600
83-4	SIMULATED	5716	29986	1506	1697	812	1192
	ACTUAL	9292	23884	3552	1871	702	1608
84-1	SIMULATED	5708	30041	1443	1658	856	1203
	ACTUAL	9624	23204	3864	1931	764	1522
84-2	SIMULATED	5694	30080	1386	1664	835	1250
	ACTUAL	9805	23360	3567	1957	794	1426
84-3	SIMULATED	5680	30062	1349	1700	861	1257
	ACTUAL	9810	23316	3567	2012	907	1297
84-4	SIMULATED	5663	30063	1317	1716	882	1268
	ACTUAL	10940	22261	3503	2057	783	1365
85-1	SIMULATED	5655	30052	1288	1730	890	1294
	ACTUAL	10945	21959	3724	2123	784	1374
85-2	SIMULATED	5639	30026	1290	1730	912	1312
	ACTUAL	11085	21605	3934	2165	785	1335

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5754	0	34	31	6	3	5828
ACTUAL		6190	38	9	4	3	0	6244
SIMULATED	NSO	0	27295	580	535	94	27	28531
ACTUAL		2932	23890	269	140	19	16	27266
SIMULATED	R/L	0	1820	981	300	13	0	3114
ACTUAL		105	279	2827	140	1	1	3353
SIMULATED	R/M	0	470	141	790	210	43	1654
ACTUAL		27	63	232	1499	93	12	1926
SIMULATED	R/H1	0	95	1	104	307	207	714
ACTUAL		5	8	1	77	560	184	835
SIMULATED	R/H2	0	64	0	16	189	799	1068
ACTUAL		0	3	0	2	48	1232	1285

DEMAND CATEGORY MIGRATION FOR QUARTER 82-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	98.7303	0.0000	0.5834	0.5319	0.1030	0.0515
ACTUAL		99.1352	0.6086	0.1441	0.0641	0.0480	0.0000
SIMULATED	NSO	0.0000	95.6679	2.0329	1.8752	0.3295	0.0946
ACTUAL		10.7533	87.6183	0.9866	0.5135	0.0697	0.0587
SIMULATED	R/L	0.0000	58.4457	31.5029	9.6339	0.4175	0.0000
ACTUAL		3.1315	8.3209	84.3126	4.1754	0.0298	0.0298
SIMULATED	R/M	0.0000	28.4160	8.5248	47.7630	12.6965	2.5998
ACTUAL		1.4019	3.2710	12.0457	77.8297	4.8287	0.6231
SIMULATED	R/H1	0.0000	13.3053	0.1401	14.5658	42.9972	28.9916
ACTUAL		0.5988	0.9581	0.1198	9.2216	67.0659	22.0359
SIMULATED	R/H2	0.0000	5.9925	0.0000	1.4981	17.6966	74.8127
ACTUAL		0.0000	0.2335	0.0000	0.1556	3.7354	95.8755

TOTAL SQUARED DIFFERENCE = 0.862454

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5746	0	3	3	1	1	5754
ACTUAL		6237	2845	133	32	9	3	9259
SIMULATED	NSO	0	29432	185	101	18	8	29744
ACTUAL		1259	22546	295	143	24	14	24281
SIMULATED	R/L	0	202	1442	93	0	0	1737
ACTUAL		21	325	2847	144	1	0	3338
SIMULATED	R/M	0	71	105	1506	93	1	1776
ACTUAL		16	68	259	1442	72	5	1862
SIMULATED	R/H1	0	13	0	78	638	90	819
ACTUAL		5	7	2	83	497	130	724
SIMULATED	R/H2	0	7	0	1	71	1000	1079
ACTUAL		11	0	0	3	82	1349	1445

DEMAND CATEGORY MIGRATION FOR QUARTER 83-1 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.8610	0.0000	0.0521	0.0521	0.0174	0.0174
ACTUAL		67.3615	30.7269	1.4364	0.3456	0.0972	0.0324
SIMULATED	NSO	0.0000	98.9510	0.6220	0.3396	0.0605	0.0269
ACTUAL		5.1851	92.8545	1.2149	0.5889	0.0988	0.0577
SIMULATED	R/L	0.0000	11.6292	83.0167	5.3541	0.0000	0.0000
ACTUAL		0.6291	9.7364	85.2906	4.3140	0.0300	0.0000
SIMULATED	R/M	0.0000	3.9977	5.9122	84.7973	5.2365	0.0563
ACTUAL		0.8593	3.6520	13.9098	77.4436	3.8668	0.2685
SIMULATED	R/H1	0.0000	1.5873	0.0000	9.5238	77.8999	10.9890
ACTUAL		0.6906	0.9669	0.2762	11.4641	68.6464	17.9558
SIMULATED	R/H2	0.0000	0.6487	0.0000	0.0927	6.5802	92.6784
ACTUAL		0.7612	0.0000	0.0000	0.2076	5.6747	93.3564

TOTAL SQUARED DIFFERENCE = 0.233904

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2

		TO						
	FROM	N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5739	0	6	1	0	0	5746
ACTUAL		7376	115	23	11	4	20	7549
SIMULATED	NSO	0	29418	194	89	17	7	29725
ACTUAL		1110	24225	280	136	24	16	25791
SIMULATED	R/L	0	112	1492	131	0	0	1735
ACTUAL		16	326	3024	166	0	4	3536
SIMULATED	R/M	0	42	81	1558	101	0	1782
ACTUAL		6	61	220	1462	90	8	1847
SIMULATED	R/H1	0	7	0	88	634	92	821
ACTUAL		2	7	1	87	476	112	685
SIMULATED	R/H2	0	4	0	0	74	1022	1100
ACTUAL		0	6	0	0	74	1421	1501

DEMAND CATEGORY MIGRATION FOR QUARTER 83-2 (PERCENT)

		TO					
	FROM	N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.8782	0.0000	0.1044	0.0174	0.0000	0.0000
ACTUAL		97.7083	1.5234	0.3047	0.1457	0.0530	0.2649
SIMULATED	NSO	0.0000	98.9672	0.6526	0.2994	0.0572	0.0235
ACTUAL		4.3038	93.9281	1.0856	0.5273	0.0931	0.0620
SIMULATED	R/L	0.0000	6.4553	85.9942	7.5504	0.0000	0.0000
ACTUAL		0.4525	9.2195	85.5204	4.6946	0.0000	0.1131
SIMULATED	R/M	0.0000	2.3569	4.5455	87.4299	5.6678	0.0000
ACTUAL		0.3249	3.3027	11.9112	79.1554	4.8728	0.4331
SIMULATED	R/H1	0.0000	0.8526	0.0000	10.7186	77.2229	11.2058
ACTUAL		0.2920	1.0219	0.1460	12.7007	69.4890	16.3504
SIMULATED	R/H2	0.0000	0.3636	0.0000	0.0000	6.7273	92.9091
ACTUAL		0.0000	0.3997	0.0000	0.0000	4.9300	94.6702

TOTAL SQUARED DIFFERENCE = 0.028877

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3

	FROM	N-S	NSO	R/L	R/M (TO)	R/H1	R/H2	TOTAL
SIMULATED	N-S	5726	0	9	1	2	1	5739
ACTUAL		8312	170	8	7	5	8	8510
SIMULATED	NSO	0	29352	161	55	10	5	29583
ACTUAL		508	23766	269	155	28	14	24740
SIMULATED	R/L	0	87	1571	115	0	0	1773
ACTUAL		13	353	2936	236	6	4	3548
SIMULATED	R/M	0	29	72	1659	106	1	1867
ACTUAL		0	67	281	1393	110	11	1862
SIMULATED	R/H1	0	6	0	77	647	96	826
ACTUAL		0	10	1	77	453	127	668
SIMULATED	R/H2	0	2	0	0	65	1054	1121
ACTUAL		0	3	1	2	139	1436	1581

DEMAND CATEGORY MIGRATION FOR QUARTER 83-3 (PERCENT)

	FROM	N-S	NSO	R/L	R/M (TO)	R/H1	R/H2
SIMULATED	N-S	99.7735	0.0000	0.1568	0.0174	0.0348	0.0174
ACTUAL		97.6733	1.9976	0.0940	0.0823	0.0588	0.0940
SIMULATED	NSO	0.0000	99.2191	0.5442	0.1859	0.0338	0.0169
ACTUAL		2.0534	96.0631	1.0873	0.6265	0.1132	0.0566
SIMULATED	R/L	0.0000	4.9069	88.6069	6.4862	0.0000	0.0000
ACTUAL		0.3664	9.9493	82.7508	6.6516	0.1691	0.1127
SIMULATED	R/M	0.0000	1.5533	3.8565	88.8591	5.6776	0.0536
ACTUAL		0.0000	3.5983	15.0913	74.8120	5.9076	0.5908
SIMULATED	R/H1	0.0000	0.7264	0.0000	9.3220	78.3293	11.6223
ACTUAL		0.0000	1.4970	0.1497	11.5269	67.8144	19.0120
SIMULATED	R/H2	0.0000	0.1784	0.0000	0.0000	5.7984	94.0232
ACTUAL		0.0000	0.1898	0.0633	0.1265	8.7919	90.8286

TOTAL SQUARED DIFFERENCE = 0.060091

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5716	0	8	2	0	0	5726
ACTUAL		8692	130	8	2	1	0	8833
SIMULATED	NSO	0	29267	129	65	7	8	29476
ACTUAL		554	23398	274	113	23	7	24369
SIMULATED	R/L	0	404	1299	110	0	0	1813
ACTUAL		28	298	3006	162	2	0	3496
SIMULATED	R/M	0	276	70	1444	114	3	1907
ACTUAL		12	50	263	1482	63	0	1870
SIMULATED	R/H1	0	30	0	76	647	77	830
ACTUAL		3	7	0	107	518	106	741
SIMULATED	R/H2	0	9	0	0	44	1104	1157
ACTUAL		3	1	1	5	95	1495	1600

DEMAND CATEGORY MIGRATION FOR QUARTER 83-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.8254	0.0000	0.1397	0.0349	0.0000	0.0000
ACTUAL		98.4037	1.4718	0.0906	0.0226	0.0113	0.0000
SIMULATED	NSO	0.0000	99.2909	0.4376	0.2205	0.0237	0.0271
ACTUAL		2.2734	96.0154	1.1244	0.4637	0.0944	0.0287
SIMULATED	R/L	0.0000	22.2835	71.6492	6.0673	0.0000	0.0000
ACTUAL		0.8009	8.5240	85.9840	4.6339	0.0572	0.0000
SIMULATED	R/M	0.0000	14.4730	3.6707	75.7210	5.9780	0.1573
ACTUAL		0.6417	2.6738	14.0642	79.2513	3.3690	0.0000
SIMULATED	R/H1	0.0000	3.6145	0.0000	9.1566	77.9518	9.2771
ACTUAL		0.4049	0.9447	0.0000	14.4399	69.9055	14.3050
SIMULATED	R/H2	0.0000	0.7779	0.0000	0.0000	3.8029	95.4192
ACTUAL		0.1875	0.0625	0.0625	0.3125	5.9375	93.4375

TOTAL SQUARED DIFFERENCE = 0.081944

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5708	0	5	3	0	0	5716
ACTUAL		9136	143	9	4	0	0	9292
SIMULATED	NSO	0	29771	137	67	7	4	29986
ACTUAL		448	23010	267	128	26	5	23884
SIMULATED	R/L	0	162	1246	98	0	0	1506
ACTUAL		21	25	3352	154	0	0	3552
SIMULATED	R/M	0	94	55	1427	119	2	1697
ACTUAL		8	20	235	1528	78	2	1871
SIMULATED	R/H1	0	9	0	63	649	91	812
ACTUAL		4	4	1	114	521	58	702
SIMULATED	R/H2	0	5	0	0	81	1106	1192
ACTUAL		7	2	0	3	139	1457	1608

DEMAND CATEGORY MIGRATION FOR QUARTER 84-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.8600	0.0000	0.0875	0.0525	0.0000	0.0000
ACTUAL		98.3211	1.5390	0.0969	0.0430	0.0000	0.0000
SIMULATED	NSO	0.0000	99.2830	0.4569	0.2234	0.0233	0.0133
ACTUAL		1.8757	96.3406	1.1179	0.5359	0.1089	0.0209
SIMULATED	R/L	0.0000	10.7570	82.7357	6.5073	0.0000	0.0000
ACTUAL		0.5912	0.7038	94.3694	4.3356	0.0000	0.0000
SIMULATED	R/M	0.0000	5.5392	3.2410	84.0896	7.0124	0.1179
ACTUAL		0.4276	1.0689	12.5601	81.6676	4.1689	0.1069
SIMULATED	R/H1	0.0000	1.1084	0.0000	7.7586	79.9261	11.2069
ACTUAL		0.5698	0.5698	0.1425	16.2393	74.2165	8.2621
SIMULATED	R/H2	0.0000	0.4195	0.0000	0.0000	6.7953	92.7852
ACTUAL		0.4353	0.1244	0.0000	0.1866	8.6443	90.6095

TOTAL SQUARED DIFFERENCE = 0.050218

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5694	0	12	1	1	0	5708
ACTUAL		8587	1012	20	4	0	1	9624
SIMULATED	NSO	0	29849	116	61	12	3	30041
ACTUAL		1171	21671	217	117	22	6	23204
SIMULATED	R/L	0	136	1200	107	0	0	1443
ACTUAL		30	557	3100	174	3	0	3864
SIMULATED	R/M	0	78	58	1425	97	0	1658
ACTUAL		8	102	229	1526	63	3	1931
SIMULATED	R/H1	0	12	0	70	669	105	856
ACTUAL		2	12	1	131	552	66	764
SIMULATED	R/H2	0	5	0	0	56	1142	1203
ACTUAL		7	6	0	5	154	1350	1522

DEMAND CATEGORY MIGRATION FOR QUARTER 84-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.7547	0.0000	0.2102	0.0175	0.0175	0.0000
ACTUAL		89.2249	10.5154	0.2078	0.0416	0.0000	0.0104
SIMULATED	NSO	0.0000	99.3609	0.3861	0.2031	0.0399	0.0100
ACTUAL		5.0465	93.3934	0.9352	0.5042	0.0948	0.0259
SIMULATED	R/L	0.0000	9.4248	83.1601	7.4151	0.0000	0.0000
ACTUAL		0.7764	14.4151	80.2277	4.5031	0.0776	0.0000
SIMULATED	R/M	0.0000	4.7045	3.4982	85.9469	5.8504	0.0000
ACTUAL		0.4143	5.2822	11.8591	79.0264	3.2626	0.1554
SIMULATED	R/H1	0.0000	1.4019	0.0000	8.1776	78.1542	12.2664
ACTUAL		0.2618	1.5707	0.1309	17.1466	72.2513	8.6387
SIMULATED	R/H2	0.0000	0.4156	0.0000	0.0000	4.6550	94.9293
ACTUAL		0.4599	0.3942	0.0000	0.3285	10.1183	88.6991

TOTAL SQUARED DIFFERENCE = 0.064809

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5680	0	10	4	0	0	5694
ACTUAL		9659	136	7	1	1	1	9805
SIMULATED	NSO	0	29893	116	62	7	2	30080
ACTUAL		109	22822	249	148	24	8	23360
SIMULATED	R/L	0	112	1166	108	0	0	1386
ACTUAL		19	275	3049	221	3	0	3567
SIMULATED	R/M	0	47	57	1448	111	1	1664
ACTUAL		10	72	258	1500	105	12	1957
SIMULATED	R/H1	0	9	0	78	673	75	835
ACTUAL		5	9	3	133	564	80	794
SIMULATED	R/H2	0	1	0	0	70	1179	1250
ACTUAL		8	2	1	9	210	1196	1426

DEMAND CATEGORY MIGRATION FOR QUARTER 84-3 (PERCENT)

	FROM	TO: N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.7541	0.0000	0.1756	0.0702	0.0000	0.0000
ACTUAL		98.5110	1.3870	0.0714	0.0102	0.0102	0.0102
SIMULATED	NSO	0.0000	99.3783	0.3856	0.2061	0.0233	0.0066
ACTUAL		0.4666	97.6969	1.0659	0.6336	0.1027	0.0342
SIMULATED	R/L	0.0000	8.0808	84.1270	7.7922	0.0000	0.0000
ACTUAL		0.5327	7.7096	85.4780	6.1957	0.0841	0.0000
SIMULATED	R/M	0.0000	2.8245	3.4255	87.0192	6.6707	0.0601
ACTUAL		0.5110	3.6791	13.1834	76.6479	5.3654	0.6132
SIMULATED	R/H1	0.0000	1.0778	0.0000	9.3413	80.5988	8.9820
ACTUAL		0.6297	1.1335	0.3778	16.7506	71.0327	10.0756
SIMULATED	R/H2	0.0000	0.0800	0.0000	0.0000	5.6000	94.3200
ACTUAL		0.5610	0.1403	0.0701	0.6311	14.7265	83.8710

TOTAL SQUARED DIFFERENCE = 0.055911

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5663	0	14	2	1	0	5680
ACTUAL		9773	34	2	1	0	0	9810
SIMULATED	NSO	0	29905	94	54	7	2	30062
ACTUAL		1124	21805	224	142	13	8	23316
SIMULATED	R/L	0	96	1157	96	0	0	1349
ACTUAL		24	313	3055	174	1	0	3567
SIMULATED	R/M	0	46	52	1488	114	0	1700
ACTUAL		11	83	219	1617	72	10	2012
SIMULATED	R/H1	0	9	0	76	696	80	861
ACTUAL		2	19	3	120	621	142	907
SIMULATED	R/H2	0	7	0	0	64	1186	1257
ACTUAL		6	7	0	3	76	1205	1297

DEMAND CATEGORY MIGRATION FOR QUARTER 84-4 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.7007	0.0000	0.2465	0.0352	0.0176	0.0000
ACTUAL		99.6228	0.3466	0.0204	0.0102	0.0000	0.0000
SIMULATED	NSO	0.0000	99.4777	0.3127	0.1796	0.0233	0.0067
ACTUAL		4.8207	93.5195	0.9607	0.6090	0.0558	0.0343
SIMULATED	R/L	0.0000	7.1164	85.7672	7.1164	0.0000	0.0000
ACTUAL		0.6728	8.7749	85.6462	4.8780	0.0280	0.0000
SIMULATED	R/M	0.0000	2.7059	3.0588	87.5294	6.7059	0.0000
ACTUAL		0.5467	4.1252	10.8847	80.3678	3.5785	0.4970
SIMULATED	R/H1	0.0000	1.0453	0.0000	8.8269	80.8362	9.2915
ACTUAL		0.2205	2.0948	0.3308	13.2304	68.4675	15.6560
SIMULATED	R/H2	0.0000	0.5569	0.0000	0.0000	5.0915	94.3516
ACTUAL		0.4626	0.5397	0.0000	0.2313	5.8597	92.9067

TOTAL SQUARED DIFFERENCE = 0.040972

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5655	0	4	4	0	0	5663
ACTUAL		10781	136	14	6	3	0	10940
SIMULATED	NSO	0	29884	130	36	12	1	30063
ACTUAL		114	21786	210	133	15	3	22261
SIMULATED	R/L	0	103	1107	107	0	0	1317
ACTUAL		25	18	3262	196	2	0	3503
SIMULATED	R/M	0	53	47	1508	106	2	1716
ACTUAL		13	16	236	1677	110	5	2057
SIMULATED	R/H1	0	8	0	75	707	92	882
ACTUAL		3	1	1	108	539	131	783
SIMULATED	R/H2	0	4	0	0	65	1199	1268
ACTUAL		9	2	1	3	115	1235	1365

DEMAND CATEGORY MIGRATION FOR QUARTER 85-1 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.8587	0.0000	0.0706	0.0706	0.0000	0.0000
ACTUAL		98.5466	1.2431	0.1280	0.0548	0.0274	0.0000
SIMULATED	NSO	0.0000	99.4046	0.4324	0.1197	0.0399	0.0033
ACTUAL		0.5121	97.8662	0.9434	0.5975	0.0674	0.0135
SIMULATED	R/L	0.0000	7.8208	84.0547	8.1245	0.0000	0.0000
ACTUAL		0.7137	0.5138	93.1202	5.5952	0.0571	0.0000
SIMULATED	R/M	0.0000	3.0886	2.7389	87.8788	6.1772	0.1166
ACTUAL		0.6320	0.7778	11.4730	81.5265	5.3476	0.2431
SIMULATED	R/H1	0.0000	0.9070	0.0000	8.5034	80.1587	10.4308
ACTUAL		0.3831	0.1277	0.1277	13.7931	68.8378	16.7305
SIMULATED	R/H2	0.0000	0.3155	0.0000	0.0000	5.1262	94.5584
ACTUAL		0.6593	0.1465	0.0733	0.2198	8.4249	90.4762

TOTAL SQUARED DIFFERENCE = 0.049662

SIMULATION RESULTS (FIFTH ITEM GROUPING)

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2

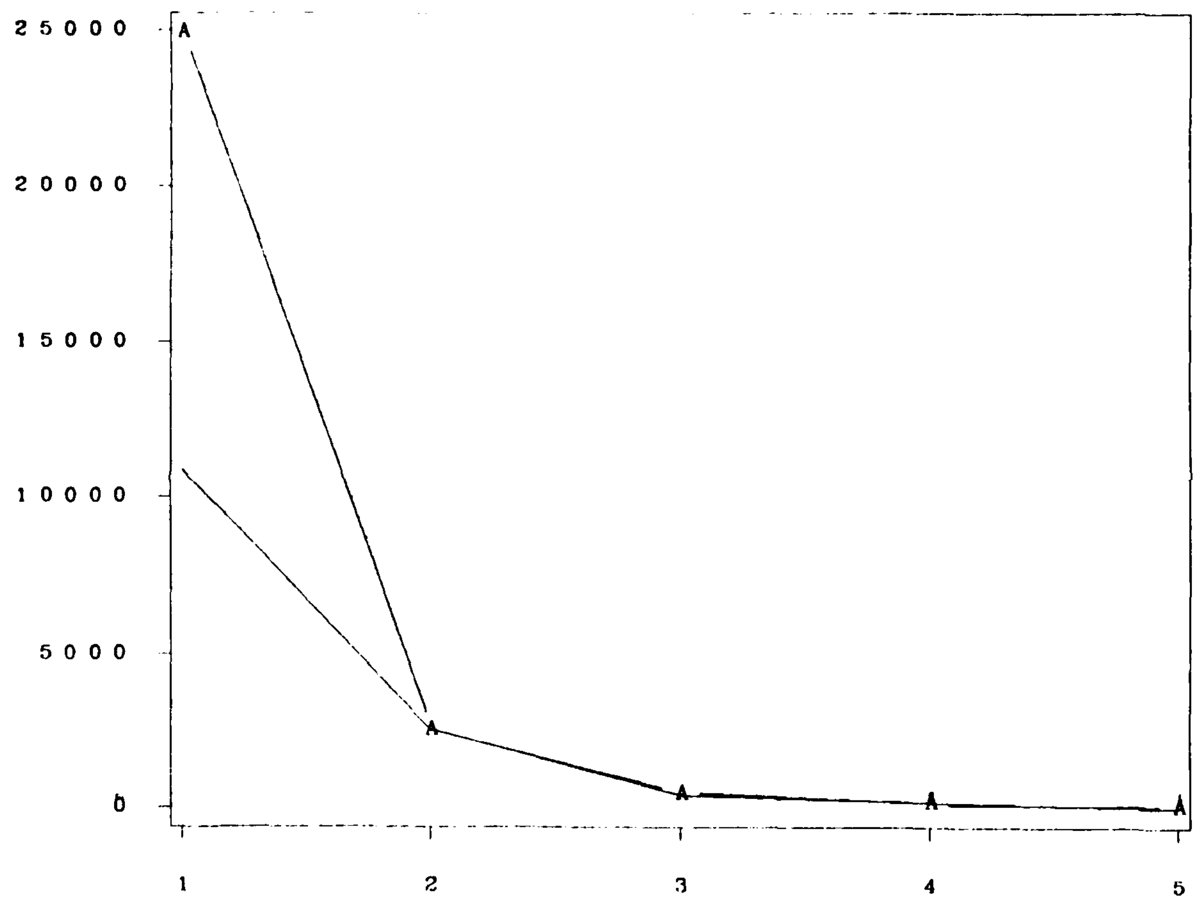
	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2	TOTAL
SIMULATED	N-S	5639	0	10	5	1	0	5655
ACTUAL		10747	182	11	2	1	2	10945
SIMULATED	NSO	0	29890	106	47	6	3	30052
ACTUAL		271	21363	175	121	24	5	21959
SIMULATED	R/L	0	81	1123	84	0	0	1288
ACTUAL		41	31	3486	165	1	0	3724
SIMULATED	R/M	0	44	51	1537	98	0	1730
ACTUAL		14	26	261	1735	80	7	2123
SIMULATED	R/H1	0	8	0	57	746	79	890
ACTUAL		4	2	1	139	553	85	784
SIMULATED	R/H2	0	3	0	0	61	1230	1294
ACTUAL		8	1	0	3	126	1236	1374

DEMAND CATEGORY MIGRATION FOR QUARTER 85-2 (PERCENT)

	FROM	TO N-S	NSO	R/L	R/M	R/H1	R/H2
SIMULATED	N-S	99.7171	0.0000	0.1768	0.0884	0.0177	0.0000
ACTUAL		98.1910	1.6629	0.1005	0.0183	0.0091	0.0183
SIMULATED	NSO	0.0000	99.4609	0.3527	0.1564	0.0200	0.0100
ACTUAL		1.2341	97.2858	0.7969	0.5510	0.1093	0.0228
SIMULATED	R/L	0.0000	6.2888	87.1894	6.5217	0.0000	0.0000
ACTUAL		1.1010	0.8324	93.6090	4.4307	0.0269	0.0000
SIMULATED	R/M	0.0000	2.5434	2.9480	88.8439	5.6647	0.0000
ACTUAL		0.6594	1.2247	12.2939	81.7240	3.7683	0.3297
SIMULATED	R/H1	0.0000	0.8989	0.0000	6.4045	83.8202	8.8764
ACTUAL		0.5102	0.2551	0.1276	17.7296	70.5357	10.8418
SIMULATED	R/H2	0.0000	0.2318	0.0000	0.0000	4.7141	95.0541
ACTUAL		0.5822	0.0728	0.0000	0.2183	9.1703	89.9563

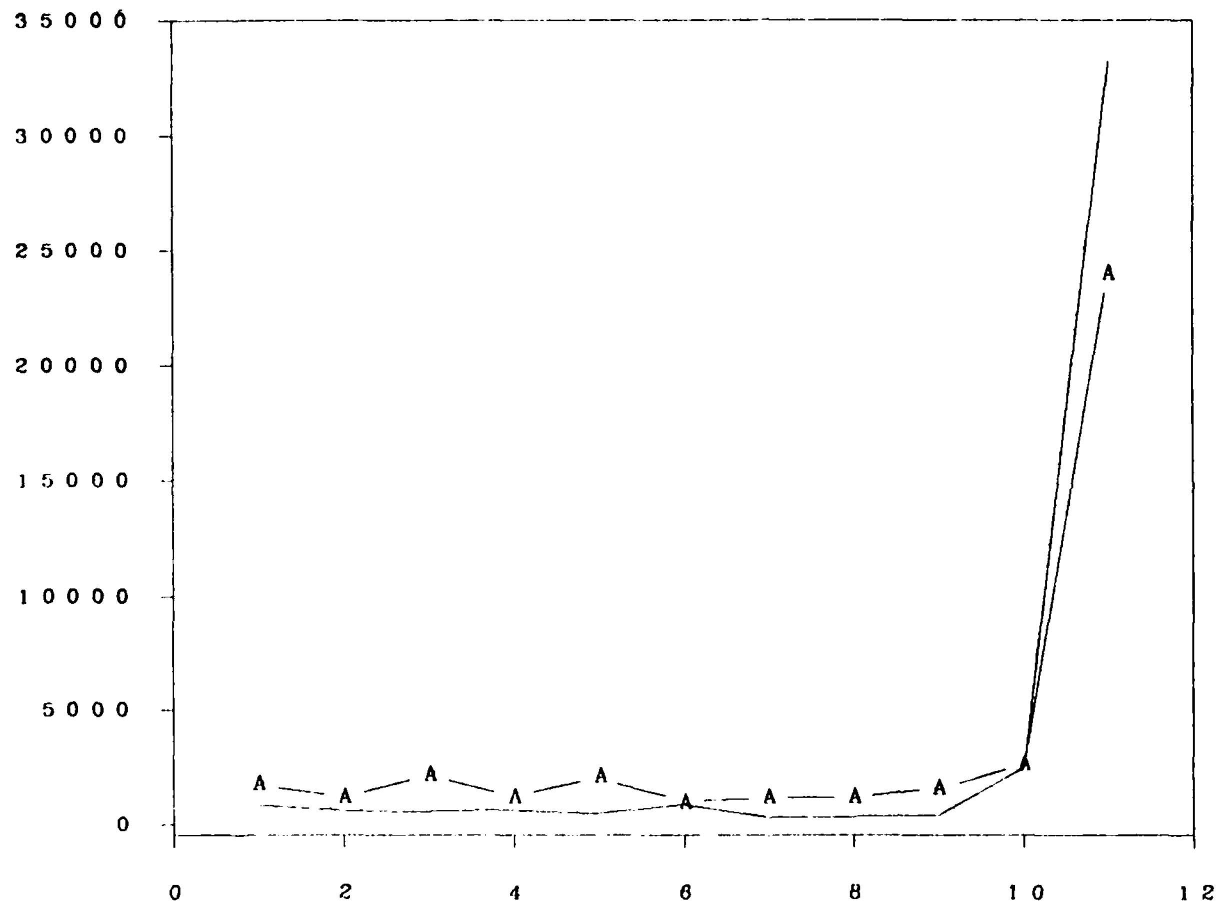
TOTAL SQUARED DIFFERENCE = 0.058776

DEMAND CATEGORY MIGRATION JUMP SIZE (RUN 5)



SIZE OF JUMP
Simulated versus (A)ctual

DEMAND CATEGORY STABILITY (RUN 5)



QUARTERS IN SAME DEMAND CATEGORY
Simulated versus (A)ctual

Appendix E

Data Collection and Simulation Input Distribution Summaries

This appendix contains data collection results for the final three item groupings which were investigated. In addition, the simulation input distributions resulting from goodness-of-fit testing are also given. Results for item grouping three are given first, item grouping four results are next, and the final set of results pertain to item grouping five.

Data Collection Results for the Third Item Grouping

Group #	Daily Demand	Requisition Size	Requisition Inter-arrivals	Item Count
1	728	871	702	1488
2	1482	1702	1275	2509
3	856	972	717	1290
4	421	471	340	455
5	99	108	79	83
6	5	7	5	3
7	8552	8875	4986	6493
8	18139	18913	10702	11802
9	12224	12908	7533	6907
10	5311	5602	3246	2723
11	1139	1209	786	588
12	51	54	31	18
13	17899	21063	18169	1163
14	11919	12787	9377	1551
15	1900	2063	1300	379
16	39	42	23	20
17	3	3	2	1
18	0	0	0	0
19	13924	21281	20890	116
20	17971	20798	19174	516
21	11240	12620	10805	664
22	3185	3521	2736	327
23	139	150	95	31
24	0	0	0	0
25	21438	61094	60858	61
26	20136	29494	29003	130
27	15984	19529	18702	202
28	7980	9084	8303	245
29	872	961	765	76
30	0	0	0	0
31	9454	35784	35707	181
32	52326	116640	116022	1397
33	59825	106471	105352	2532
34	36986	53655	52486	2623
35	8526	11745	11216	1189
36	82	93	78	41

Distribution Fitting Results for the Third Item Grouping

Group	Type of Simulation	Best Continuous	Best Discrete	Simulation Input
1	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
2	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
3	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Gamma
4	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
5	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
6	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
7	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
8	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
9	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Gamma
10	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Gamma
11	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
12	NE-Size	Gamma	No Test	Empirical
	Arrive	Weibull	Geometric	Weibull
13	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
14	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
15	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
16	NE-Size	Expon.	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
17	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
18	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical

(NE = Next-Event and DD = Daily Demand)

Distribution Fitting Results for the Third Item Grouping
(Continued)

Group	Type of Simulation	Best Continuous	Best Discrete	Simulation Input
19	DD	Gamma	Geometric	Empirical
20	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
21	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
22	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
23	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
24	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
25	DD	Weibull	Geometric	Empirical
26	DD	Gamma	Geometric	Empirical
27	NE-Size	Expon.	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
28	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
29	NE-Size	Expon.	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
30	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
31	DD	Gamma	Geometric	Empirical
32	DD	Gamma	Geometric	Empirical
33	DD	Gamma	Geometric	Empirical
34	DD	Gamma	Geometric	Empirical
35	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
36	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical

(NE = Next-Event and DD = Daily Demand)

Data Collection Results for the Fourth Item Grouping

Group #	Daily Demand	Requisition Size	Requisition Inter-arrivals	Item Count
1	5419	5616	3270	7561
2	3726	3969	2266	418
3	135	161	152	2
4	0	0	0	0
5	9982	10217	5781	13271
6	9424	10085	5891	1037
7	109	118	110	3
8	106	195	195	0
9	7332	7587	4303	8853
10	8844	9529	5745	1173
11	84	112	106	1
12	0	0	0	0
13	1456	1510	851	1737
14	2376	2578	1699	303
15	14	15	15	0
16	0	0	0	0
17	294	302	154	200
18	6756	7207	5064	821
19	8000	9107	8556	130
20	2849	4447	4395	12
21	388	397	210	289
22	9824	10485	7429	1219
23	1707	1905	1738	43
24	0	0	0	0
25	159	168	86	102
26	1750	1904	1213	292
27	22	24	19	1
28	0	0	0	0
29	2	2	1	2
30	9	10	6	3
31	0	0	0	0
32	0	0	0	0

Data Collection Results for the Fourth Item Grouping
(Continued)

Group #	Daily Demand	Requisition Size	Requisition Inter-arrivals	Item Count
33	37	41	40	2
34	328	359	294	28
35	5472	6620	6400	61
36	8087	14261	14156	25
37	78	92	82	19
38	3866	4241	3455	285
39	13932	16339	15513	212
40	95	126	124	0
41	155	168	113	53
42	8031	8882	7039	699
43	5287	6059	5621	123
44	0	0	0	0
45	57	61	39	13
46	1005	1089	795	132
47	29	32	29	2
48	0	0	0	0
49	284	720	719	1
50	15	16	14	2
51	2309	3034	2972	14
52	28284	93108	92860	63
53	324	560	558	1
54	166	180	143	12
55	15133	20202	19781	112
56	56839	125192	124543	175
57	599	767	759	7
58	2075	2367	2045	107
59	53755	67538	65454	560
60	46573	94855	94323	142
61	246	280	257	22
62	4135	4649	3915	267
63	19114	23954	23070	280
64	3758	7128	7079	17

Distribution Fitting Results for the Fourth Item Grouping

Group	Type of Simulation	Best Continuous	Best Discrete	Simulation Input
1	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
2	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
3	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
4	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
5	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
6	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
7	NE-Size	Expon.	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
8	NE-Size	Expon.	Geometric	Geometric
	Arrive	Expon.	Geometric	Empirical
9	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
10	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Gamma
11	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
12	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
13	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
14	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
15	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
16	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
17	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
18	NE-Size	Gamma	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
19	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
20	DD	Gamma	Geometric	Empirical
21	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical

(NE = Next-Event and DD = Daily Demand)

Distribution Fitting Results for the Fourth Item Grouping
(Continued)

Group	Type of Simulation	Best Continuous	Best Discrete	Simulation Input
22	NE-Size	Gamma	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
23	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
24	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
25	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
26	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
27	NE-Size	Weibull	No Test	Empirical
	Arrive	No Test	No Test	Empirical
28	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
29	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
30	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
31	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
32	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
33	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
34	NE-Size	Weibull	Geometric	Weibull
	Arrive	Weibull	Geometric	Weibull
35	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
36	DD	Gamma	Geometric	Empirical
37	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Weibull
38	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
39	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
40	NE-Size	Expon.	Geometric	Empirical
	Arrive	Expon.	Geometric	Geometric
41	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Gamma
42	NE-Size	Gamma	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical

(NE = Next-Event and DD = Daily Demand)

Distribution Fitting Results for the Fourth Item Grouping
(Continued)

Group	Type of Simulation	Best Continuous	Best Discrete	Simulation Input
43	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
44	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
45	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Gamma
46	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
47	NE-Size	Expon.	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
48	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
49	DD	Weibull	Geometric	Empirical
50	NE-Size	No Test	No Test	Empirical
	Arrive	No Test	No Test	Empirical
51	DD	Weibull	Geometric	Empirical
52	DD	Gamma	Geometric	Empirical
53	DD	Gamma	Geometric	Empirical
54	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
55	DD	Expon.	Geometric	Empirical
56	DD	Gamma	Geometric	Empirical
57	NE-Size	Weibull	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
58	NE-Size	Gamma	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
59	DD	Gamma	Geometric	Empirical
60	DD	Gamma	Geometric	Empirical
61	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
62	NE-Size	Gamma	Geometric	Empirical
	Arrive	Expon.	Geometric	Empirical
63	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
64	DD	Gamma	Geometric	Empirical

(NE = Next-Event and DD = Daily Demand)

Data Collection Results for the Fifth Item Grouping

Group #	Daily Demand	Requisition Size	Requisition Inter-arrivals	Item Count
1	16374	16828	9526	31197
2	7472	7884	4847	708
3	1830	2256	1676	151
4	892	1237	949	67
5	244	283	225	10
6	25318	26999	16153	4354
7	13730	14828	9813	1125
8	2765	3011	2052	235
9	1209	1317	870	86
10	271	294	190	28
11	7905	8758	7251	524
12	8201	9099	7898	325
13	1869	2064	1761	81
14	842	939	820	28
15	220	241	205	12
16	29197	36249	34613	476
17	68526	84695	81773	775
18	17242	21557	20807	195
19	8060	10099	9800	78
20	2077	2620	2543	20
21	6014	12014	11935	25
22	60740	119956	119215	202
23	40982	102790	102361	106
24	35055	92718	92371	89
25	3800	11834	11793	12

Distribution Fitting Results for the Fifth Item Grouping

Group	Type of Simulation	Best Continuous	Best Discrete	Simulation Input
1	NE-Size	Expon.	Poisson	Empirical
	Arrive	Gamma	Geometric	Empirical
2	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
3	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
4	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
5	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
6	NE-Size	Expon.	Poisson	Poisson
	Arrive	Gamma	Geometric	Empirical
7	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
8	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
9	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
10	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
11	NE-Size	Expon.	Geometric	Geometric
	Arrive	Gamma	Geometric	Empirical
12	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
13	NE-Size	Weibull	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
14	NE-Size	Gamma	Geometric	Empirical
	Arrive	Weibull	Geometric	Empirical
15	NE-Size	Weibull	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
16	NE-Size	Expon.	Geometric	Empirical
	Arrive	Gamma	Geometric	Empirical
17	DD	Gamma	Geometric	Empirical
18	DD	Gamma	Geometric	Empirical
19	DD	Gamma	Geometric	Empirical
20	DD	Gamma	Geometric	Empirical
21	DD	Expon.	Geometric	Empirical
22	DD	Gamma	Geometric	Empirical
23	DD	Gamma	Geometric	Empirical
24	DD	Gamma	Geometric	Empirical
25	DD	Gamma	Geometric	Empirical

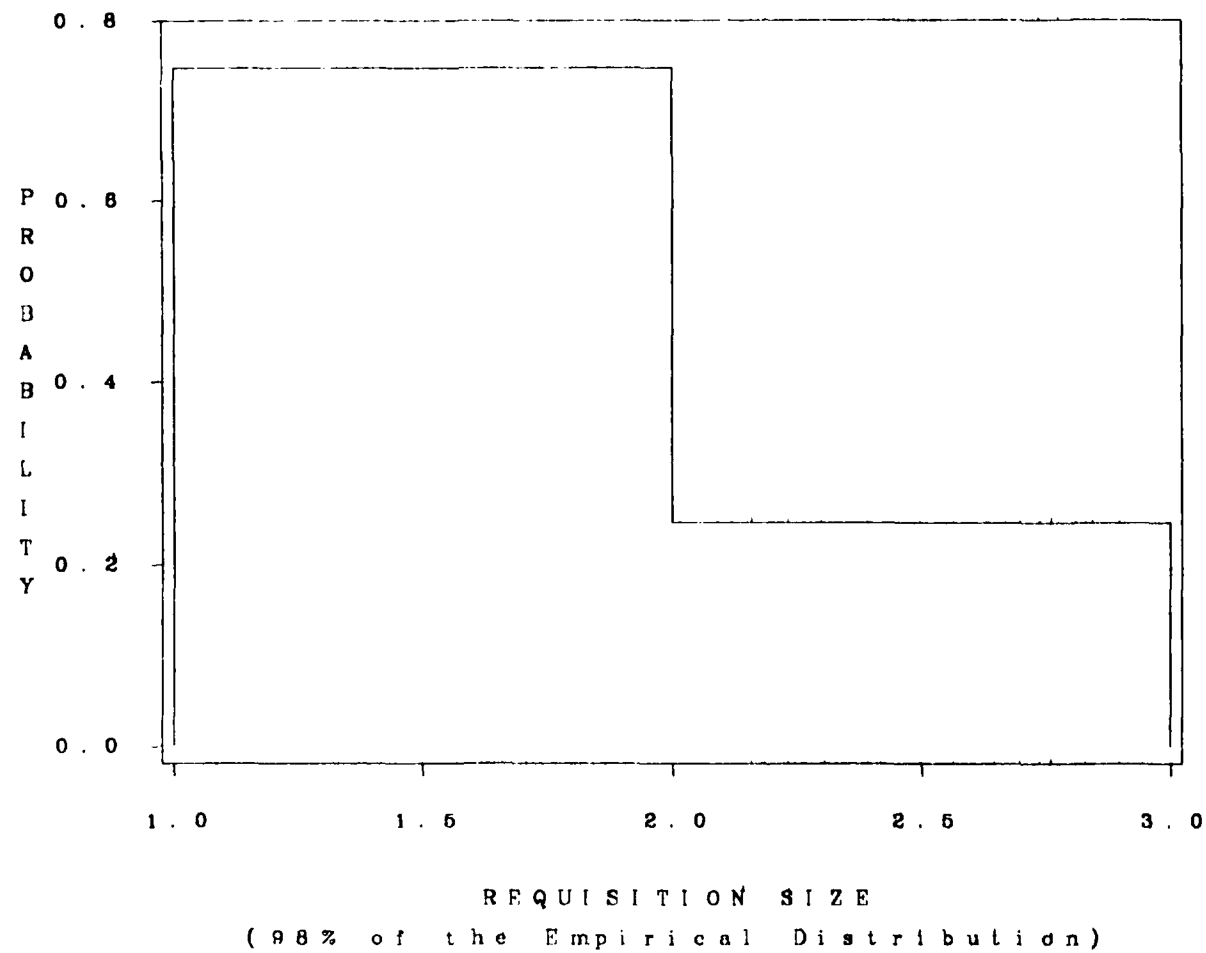
(NE = Next-Event and DD = Daily Demand)

Appendix F

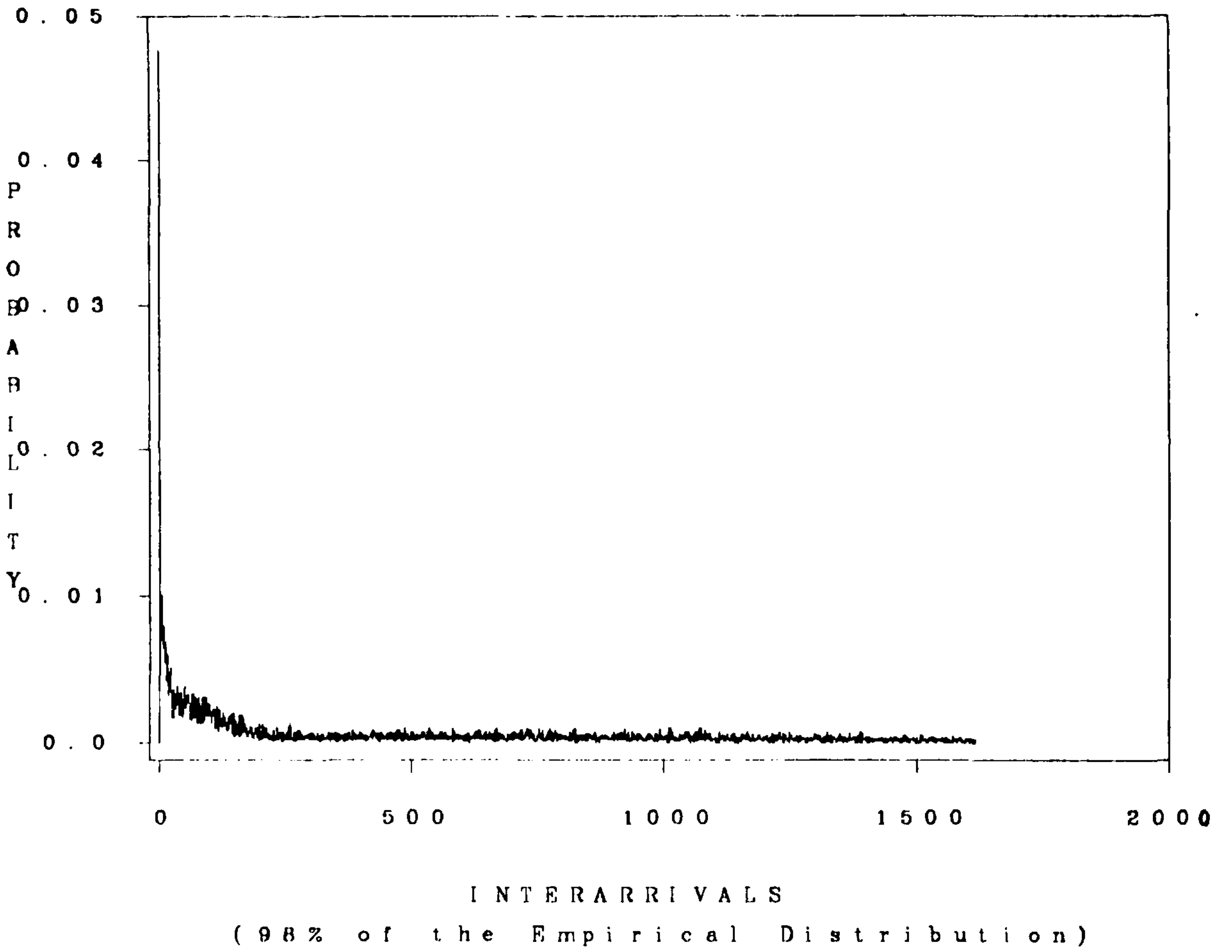
Empirical Distributions for the Fifth Item Grouping

This appendix contains plots of the empirical distributions for the fifth item grouping. The empirical requisition size and requisition inter-arrival distributions are given for groups which are modeled using a next-event simulation. The empirical daily demand distribution is given for groups which are modeled using a daily demand simulation.

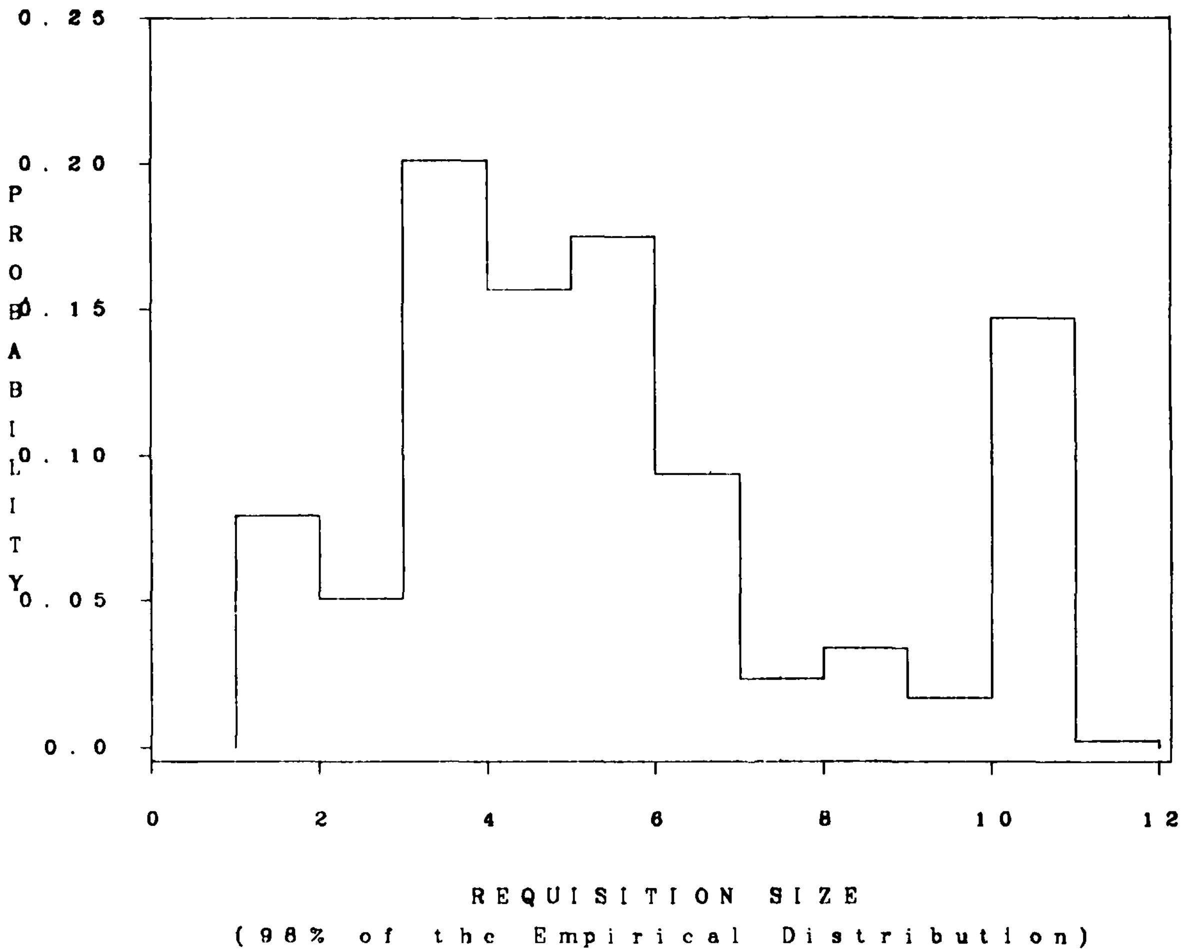
EMPIRICAL REQUISITION SIZE (GROUP 1)



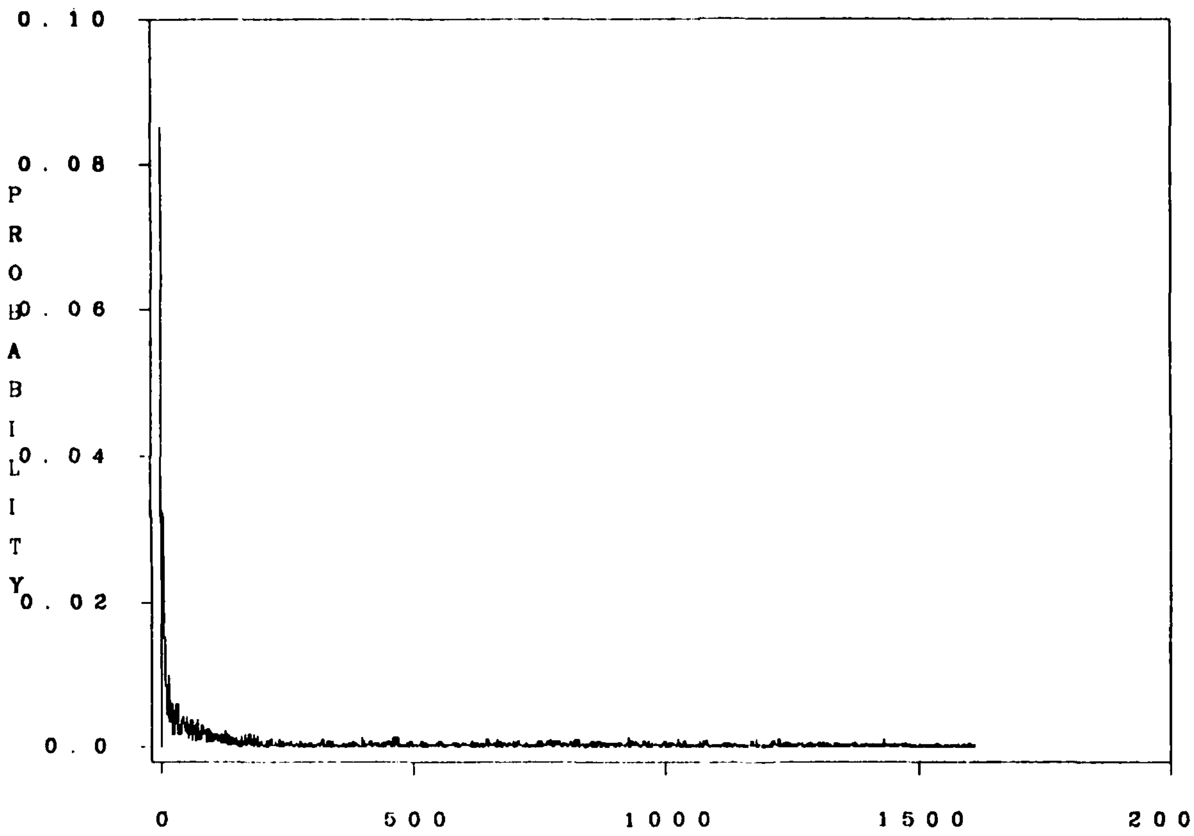
EMPIRICAL INTERARRIVALS (GROUP 1)



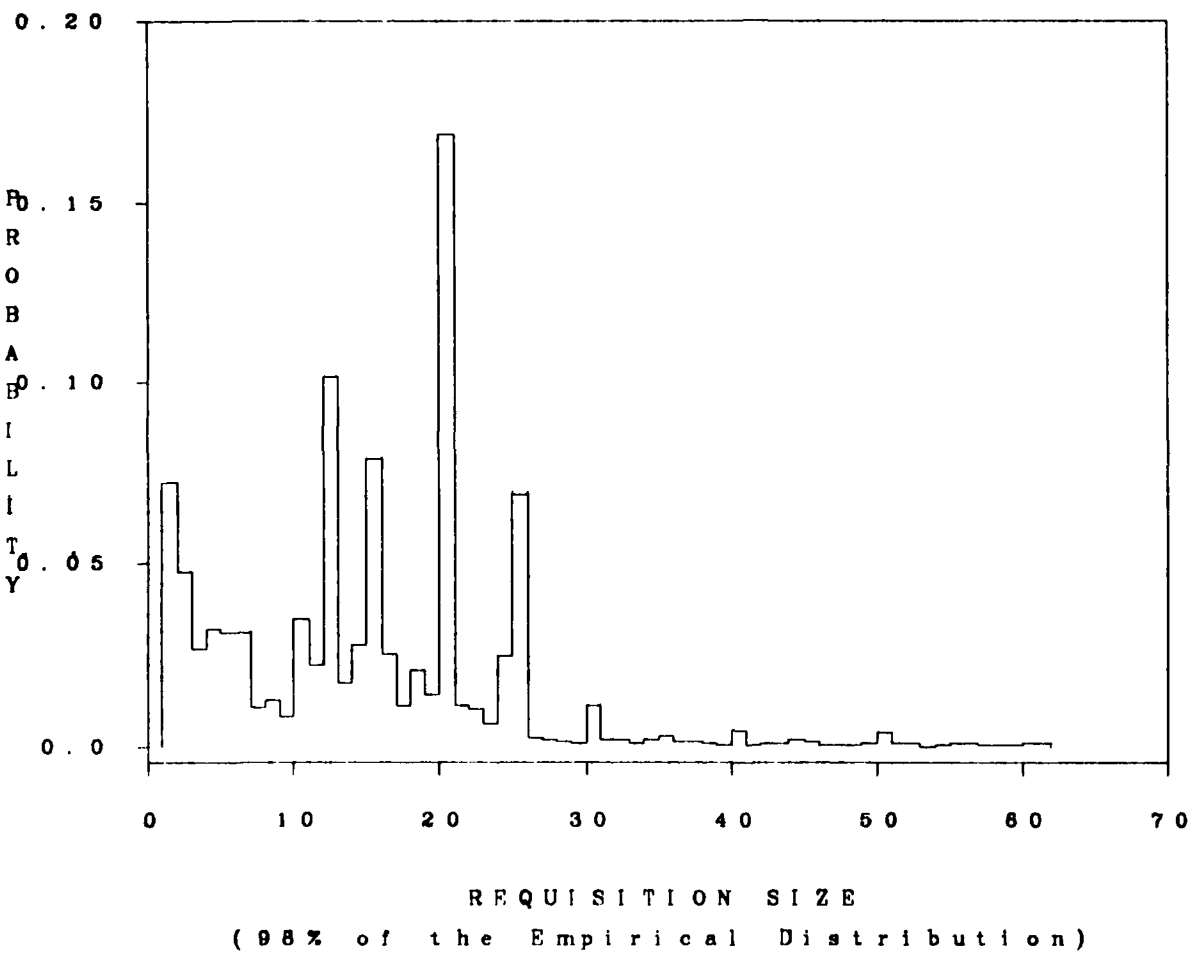
EMPIRICAL REQUISITION SIZE (GROUP 2)



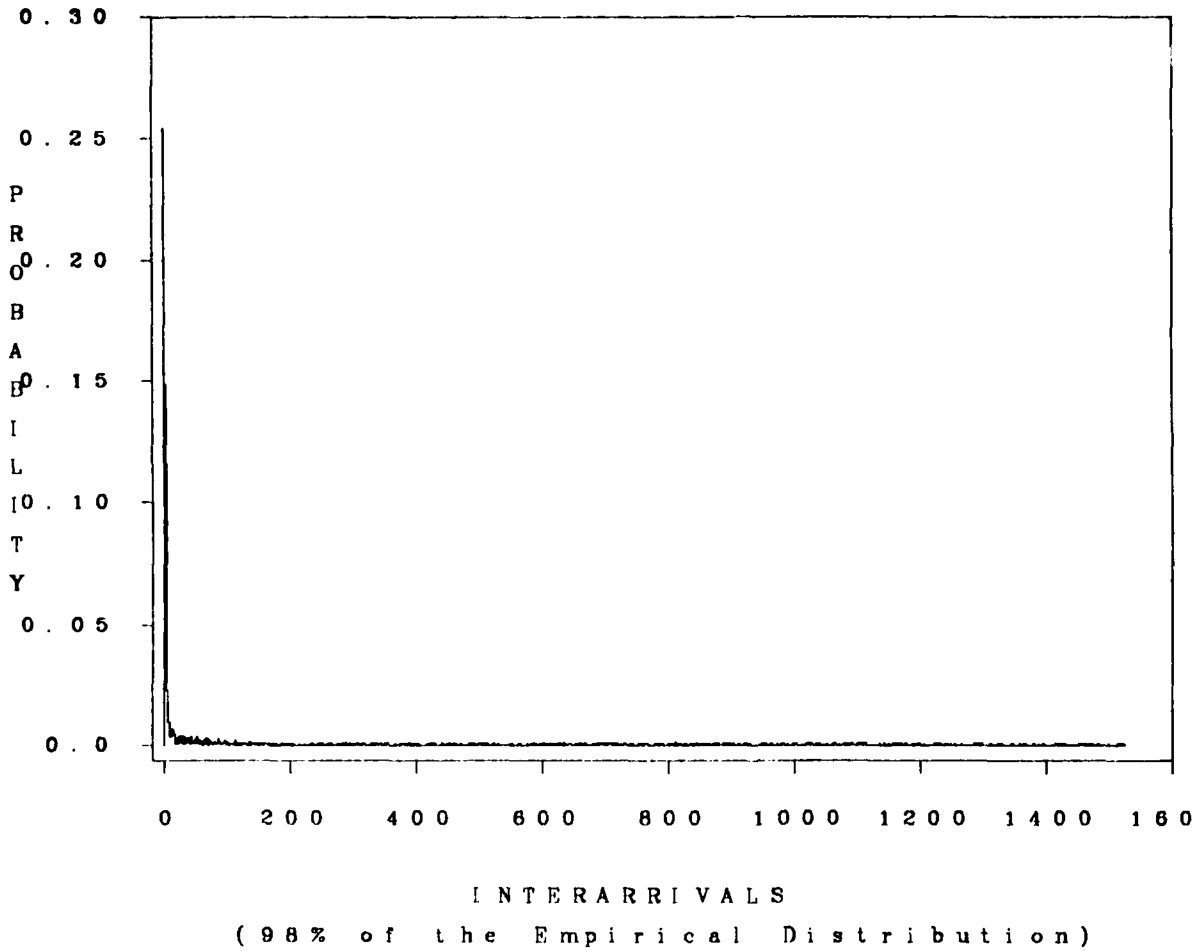
EMPIRICAL INTERARRIVALS (GROUP 2)



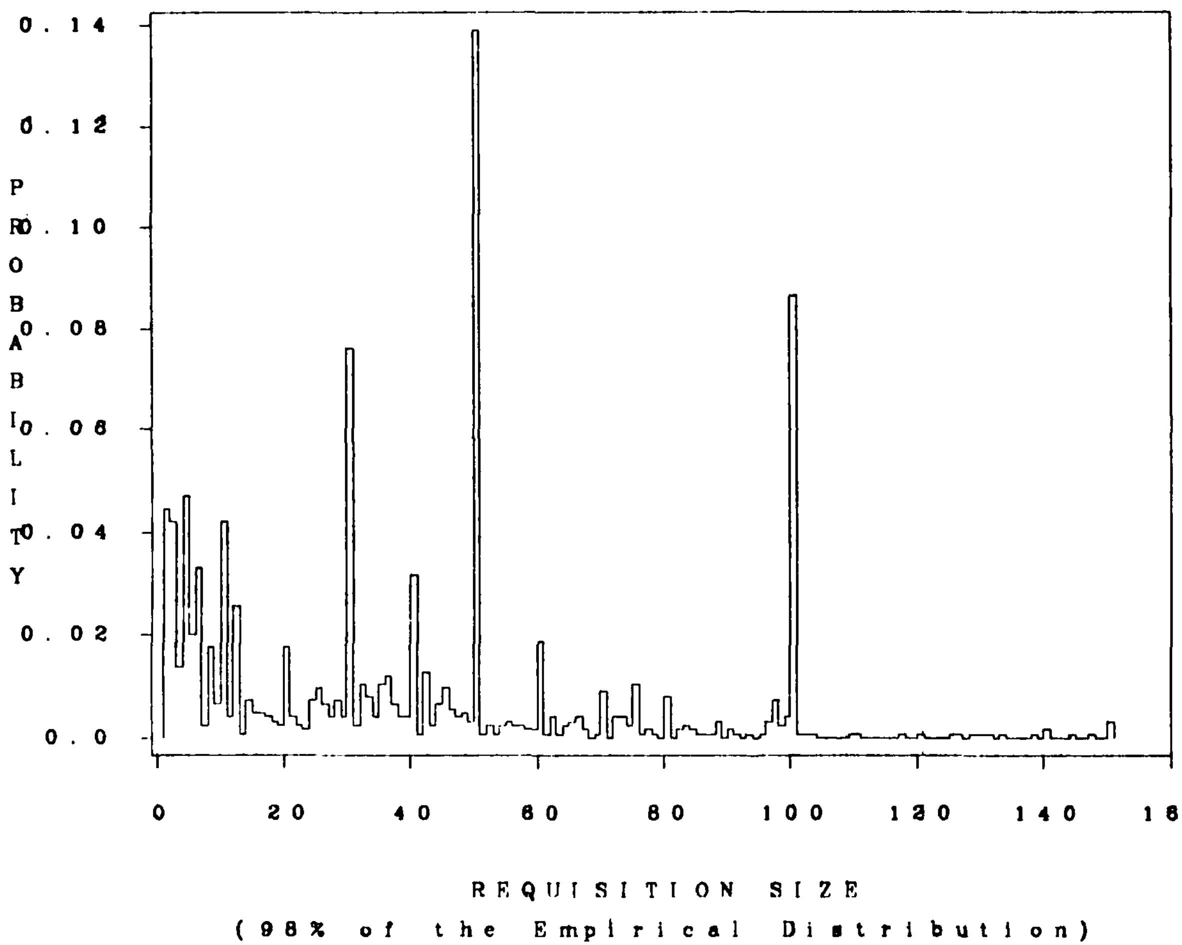
EMPIRICAL REQUISITION SIZE (GROUP 3)



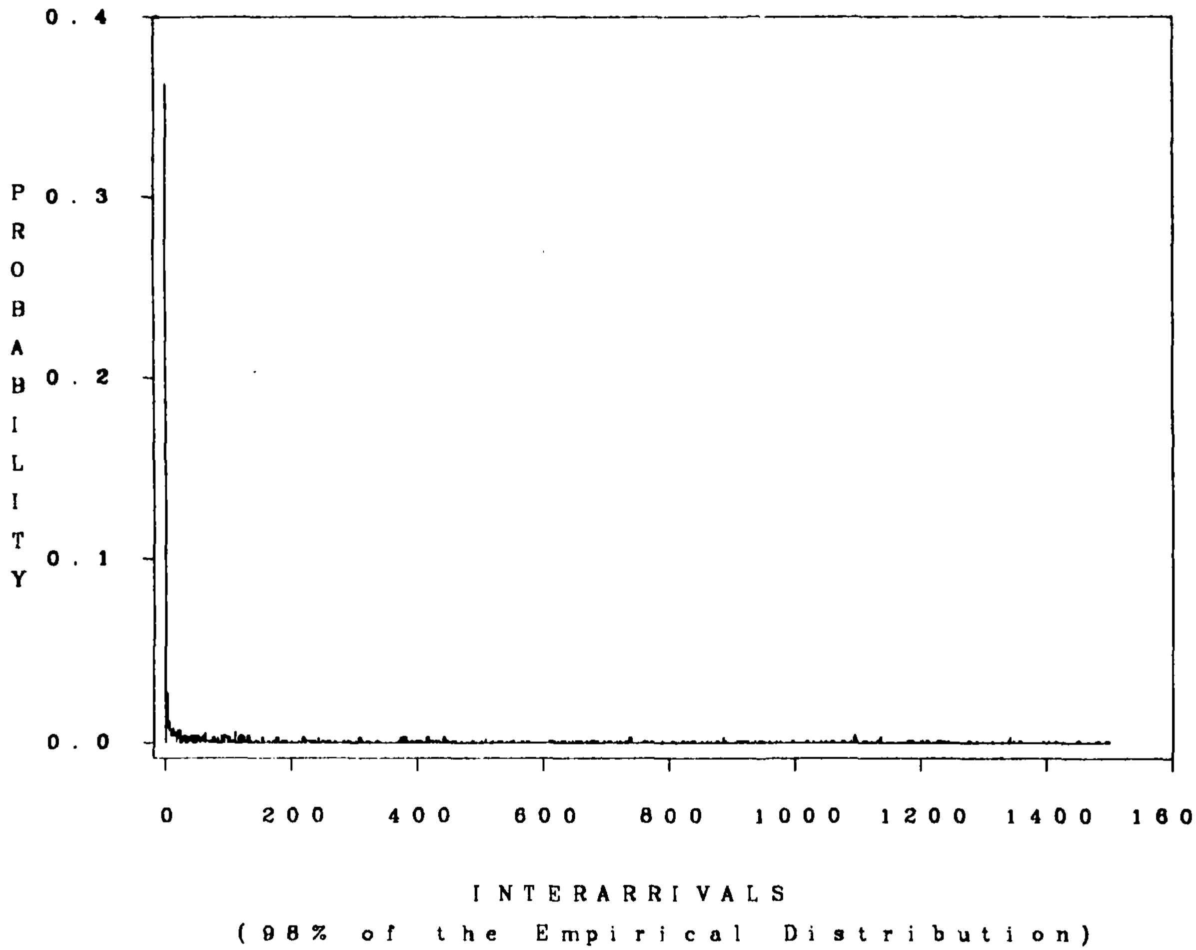
EMPIRICAL INTERARRIVALS (GROUP 3)



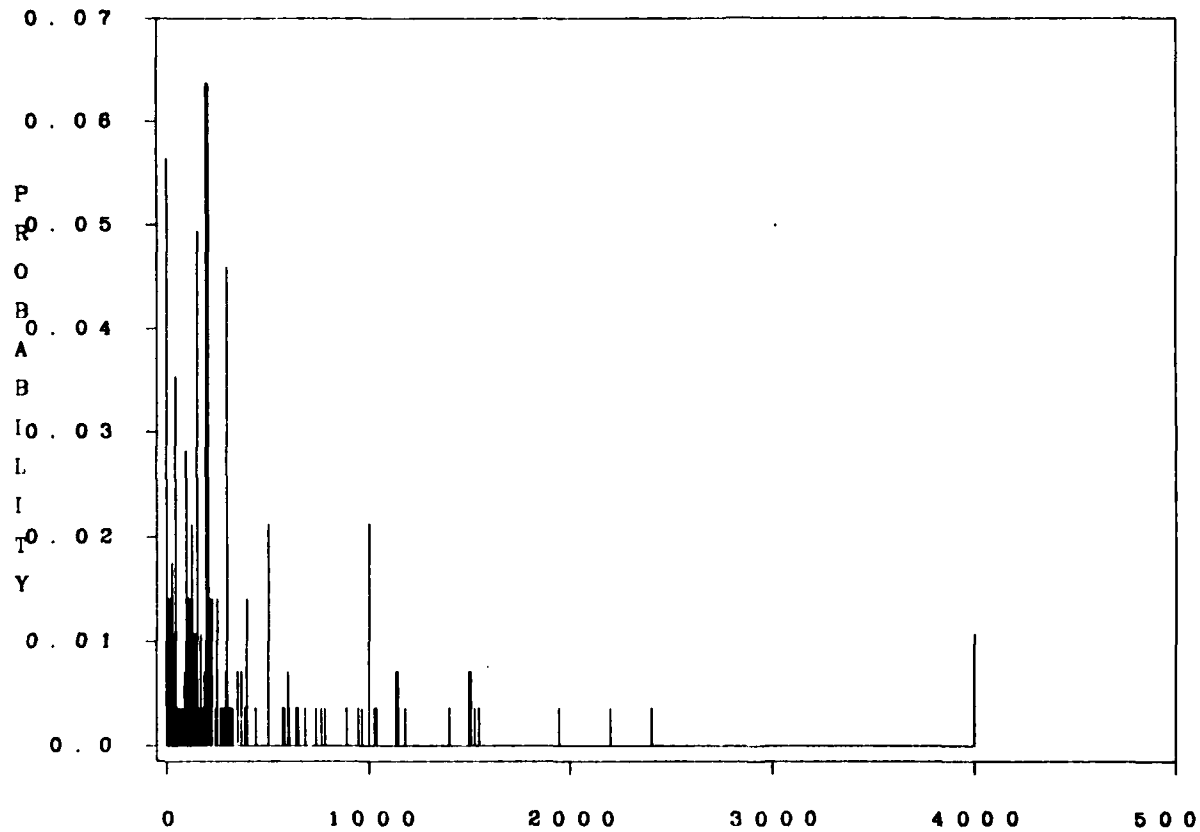
EMPIRICAL REQUISITION SIZE (GROUP 4)



EMPIRICAL INTERARRIVALS (GROUP 4)

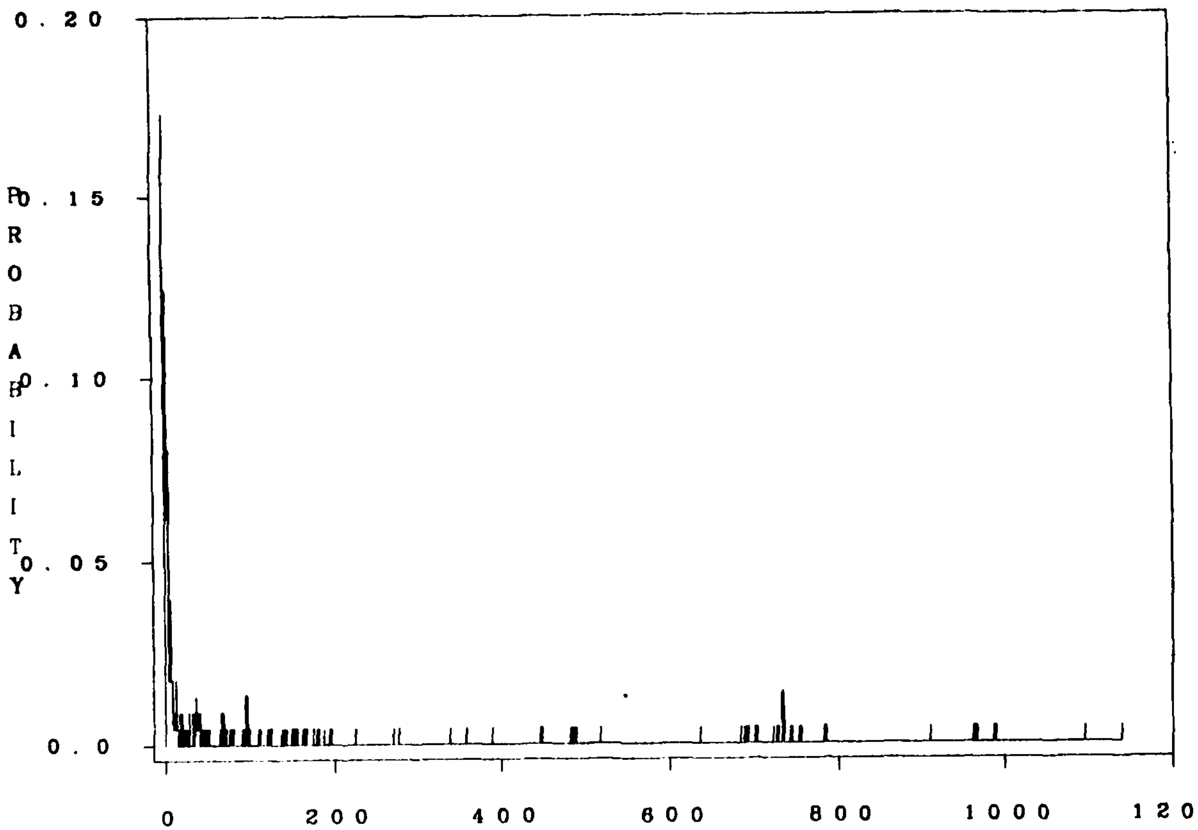


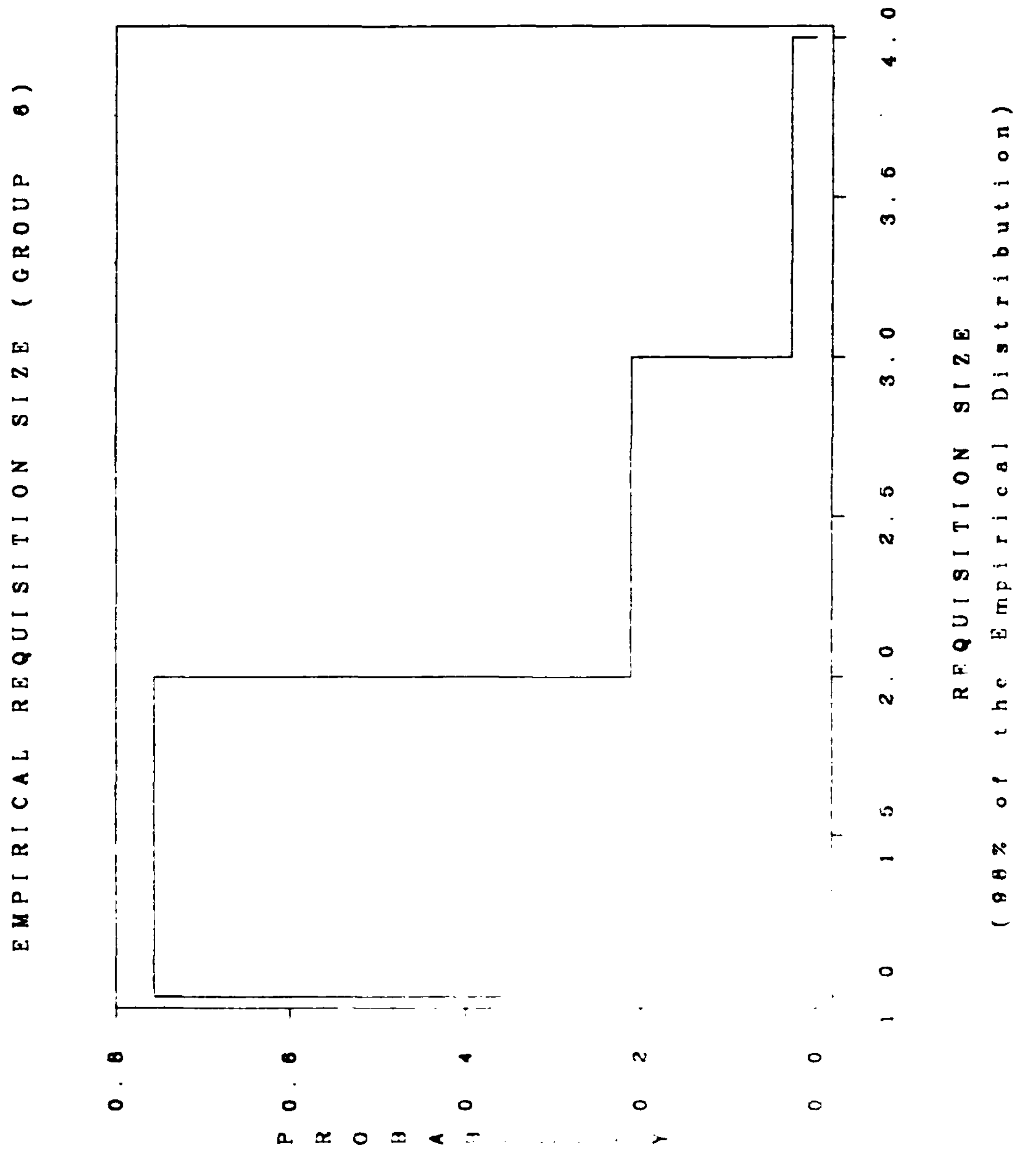
EMPIRICAL REQUISITION SIZE (GROUP 5)



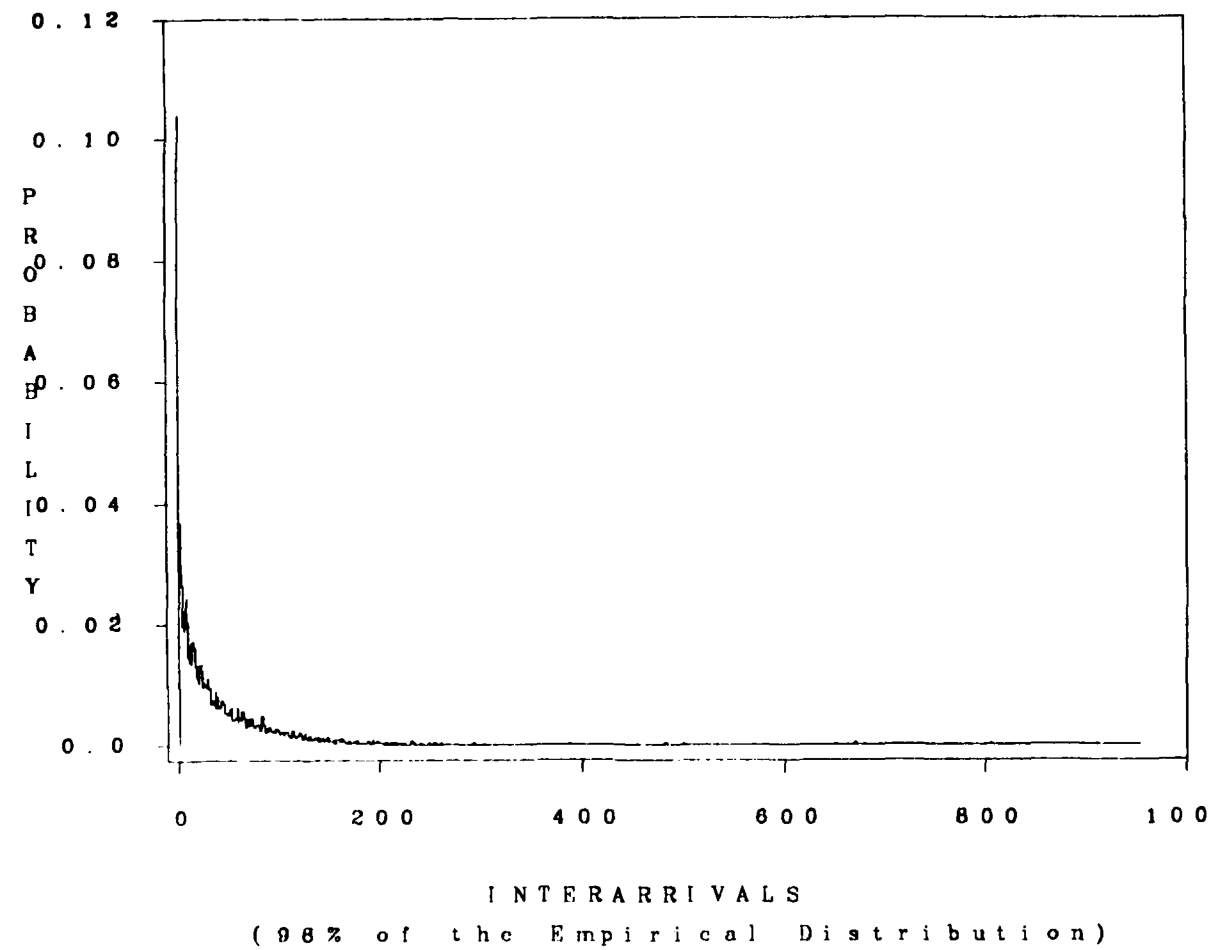
REQUISITION SIZE
(98% of the Empirical Distribution)

EMPIRICAL INTERARRIVALS (GROUP 5)

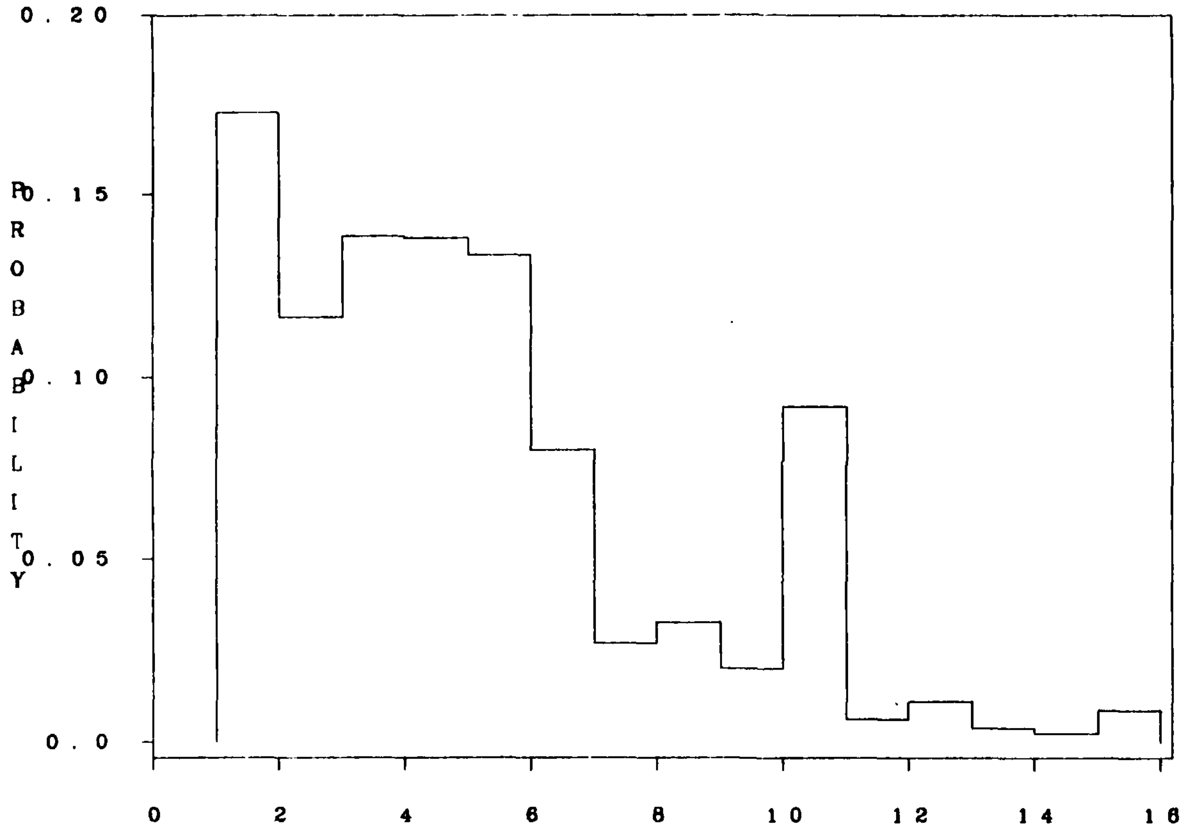



EMPIRICAL REQUISITION SIZE (GROUP 6)
PROBABILITY
0.8
0.6
0.4
0.2
0.0
1.0
1.5
2.0
2.5
3.0
3.5
4.0
REQUISITION SIZE
(98% of the Empirical Distribution)

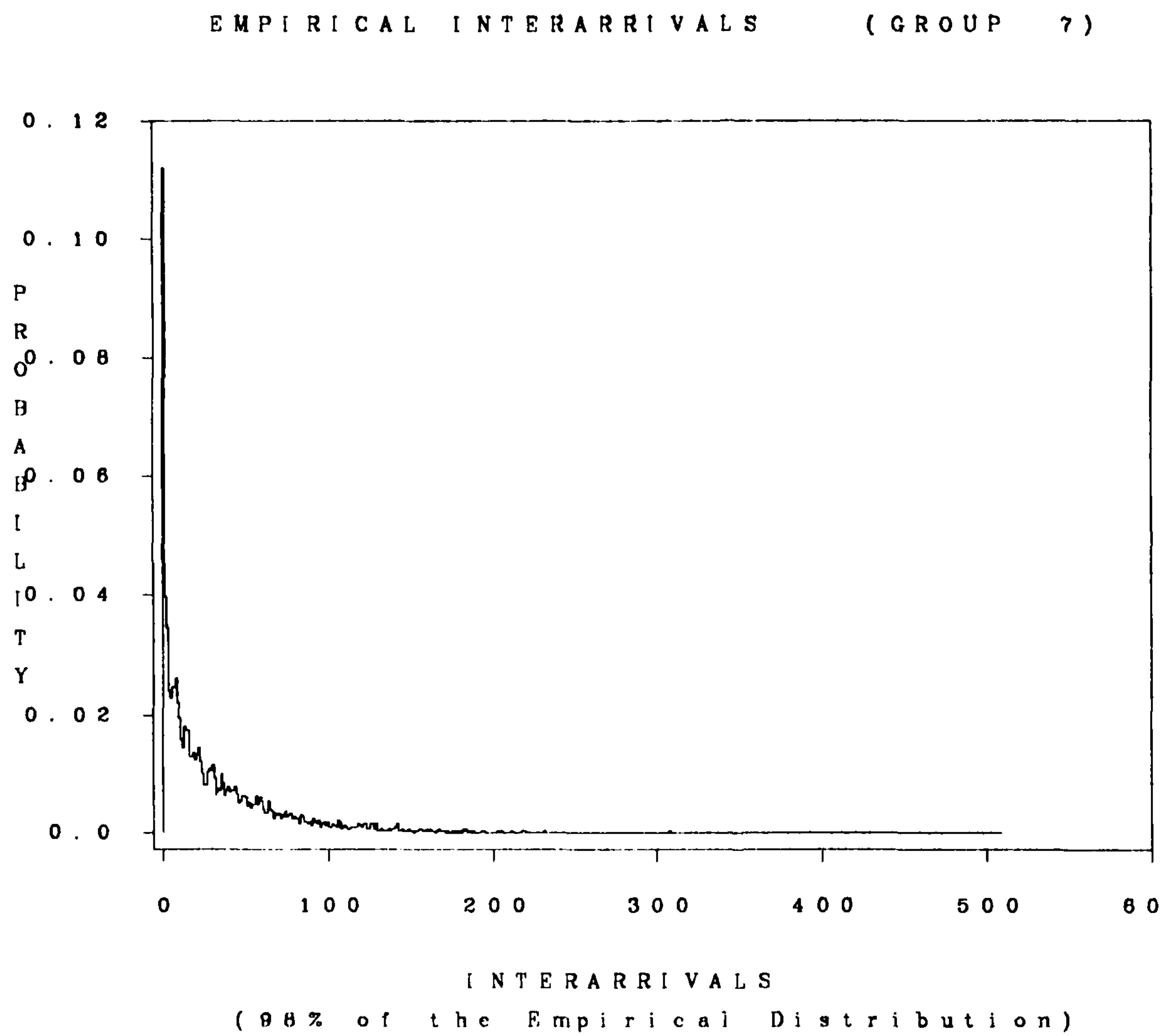
EMPIRICAL INTERARRIVALS (GROUP 6)



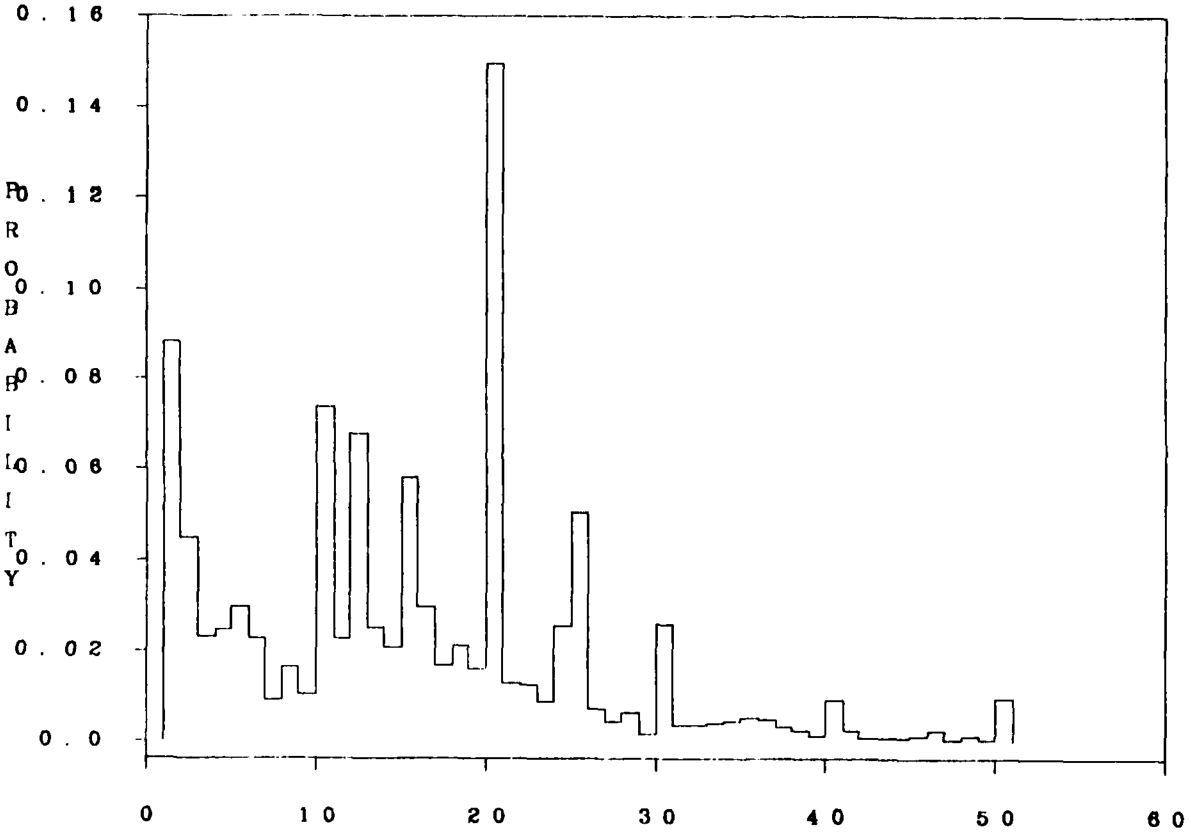
EMPIRICAL REQUISITION SIZE (GROUP 7)



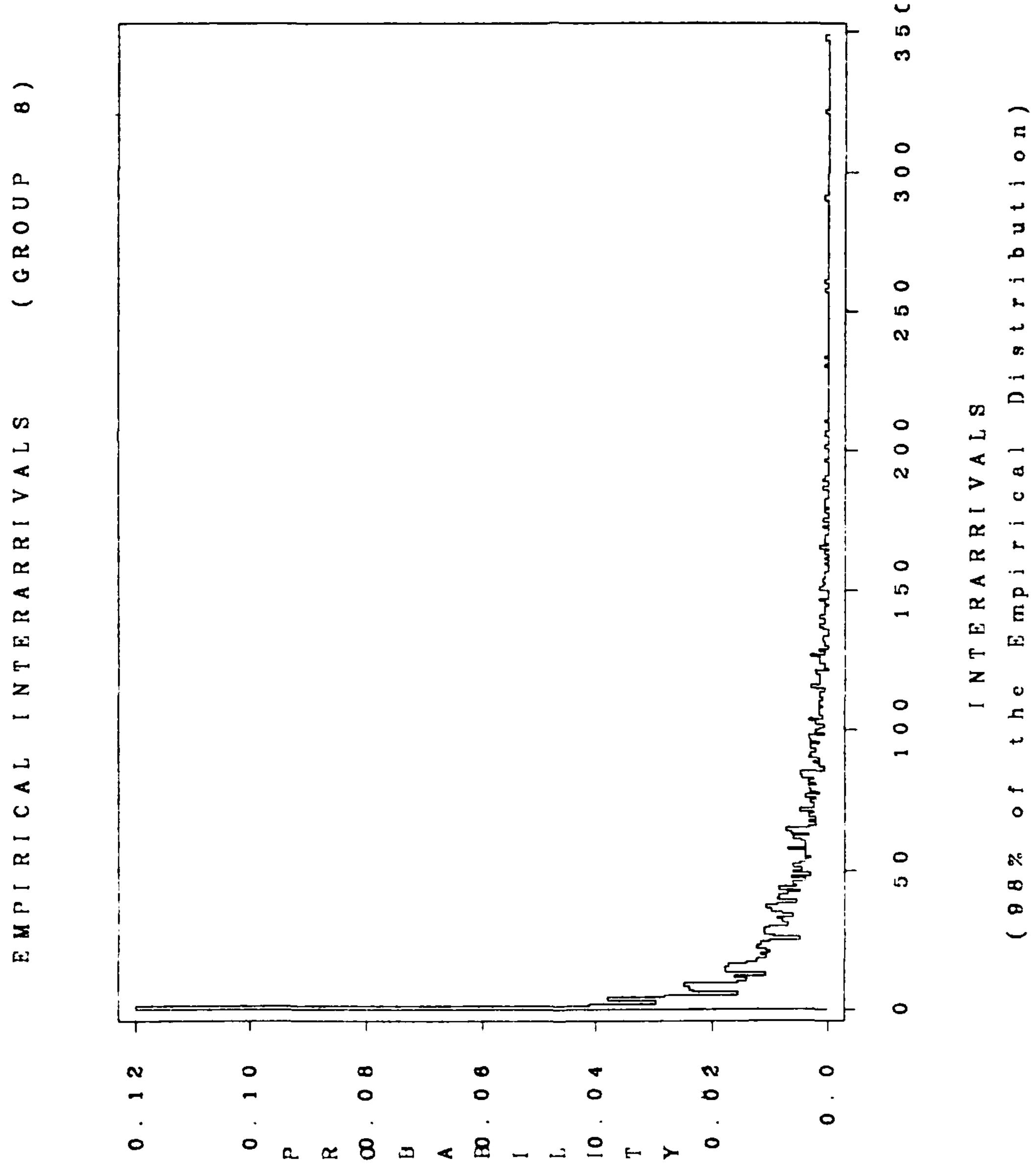
REQUISITION SIZE
(98% of the Empirical Distribution)


EMPIRICAL INTERARRIVALS (GROUP 7)
0.12
0.10
0.08
0.06
0.04
0.02
0.0
PROBABILITY
0
100
200
300
400
500
60
INTERARRIVALS
(98% of the Empirical Distribution)

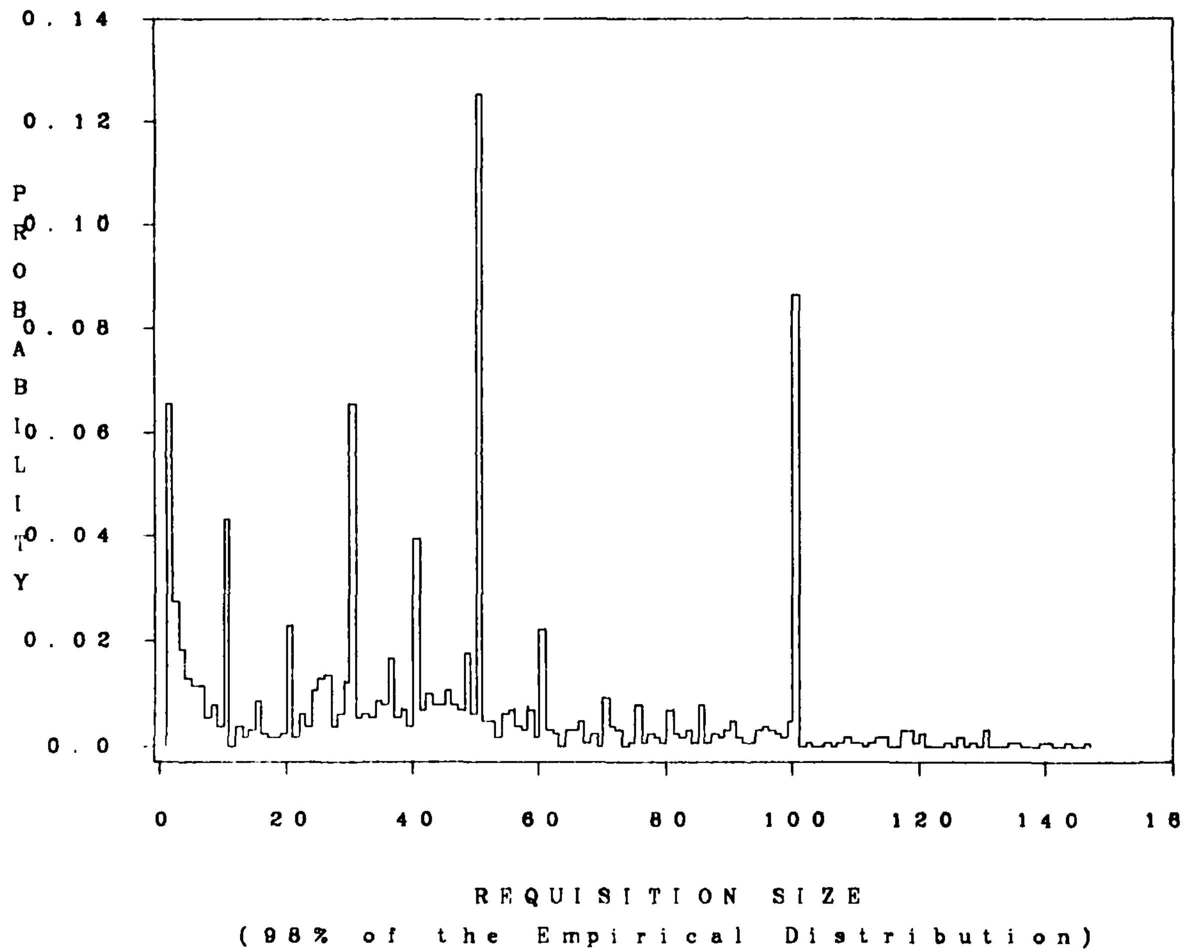
EMPIRICAL REQUISITION SIZE (GROUP 8)

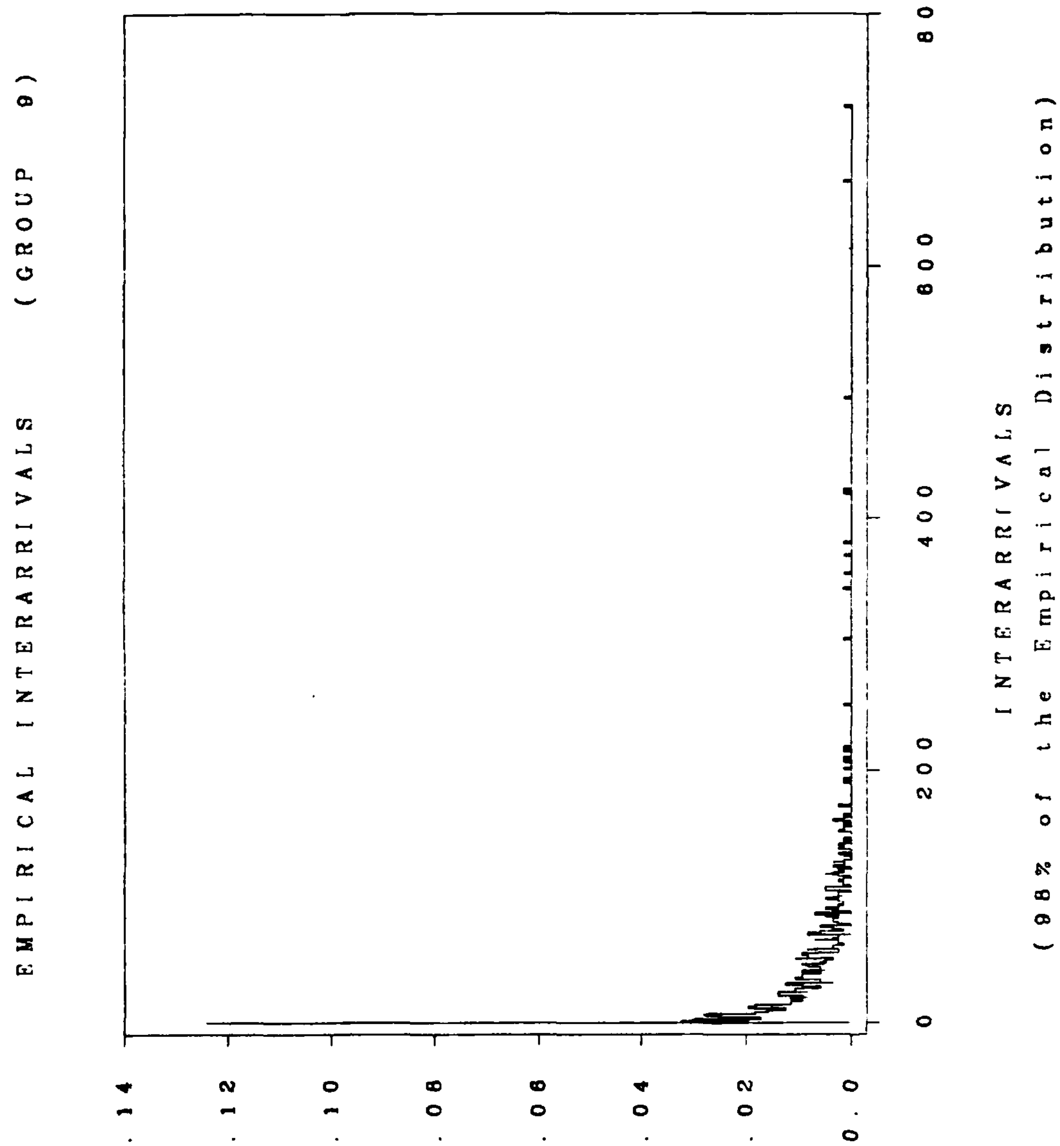


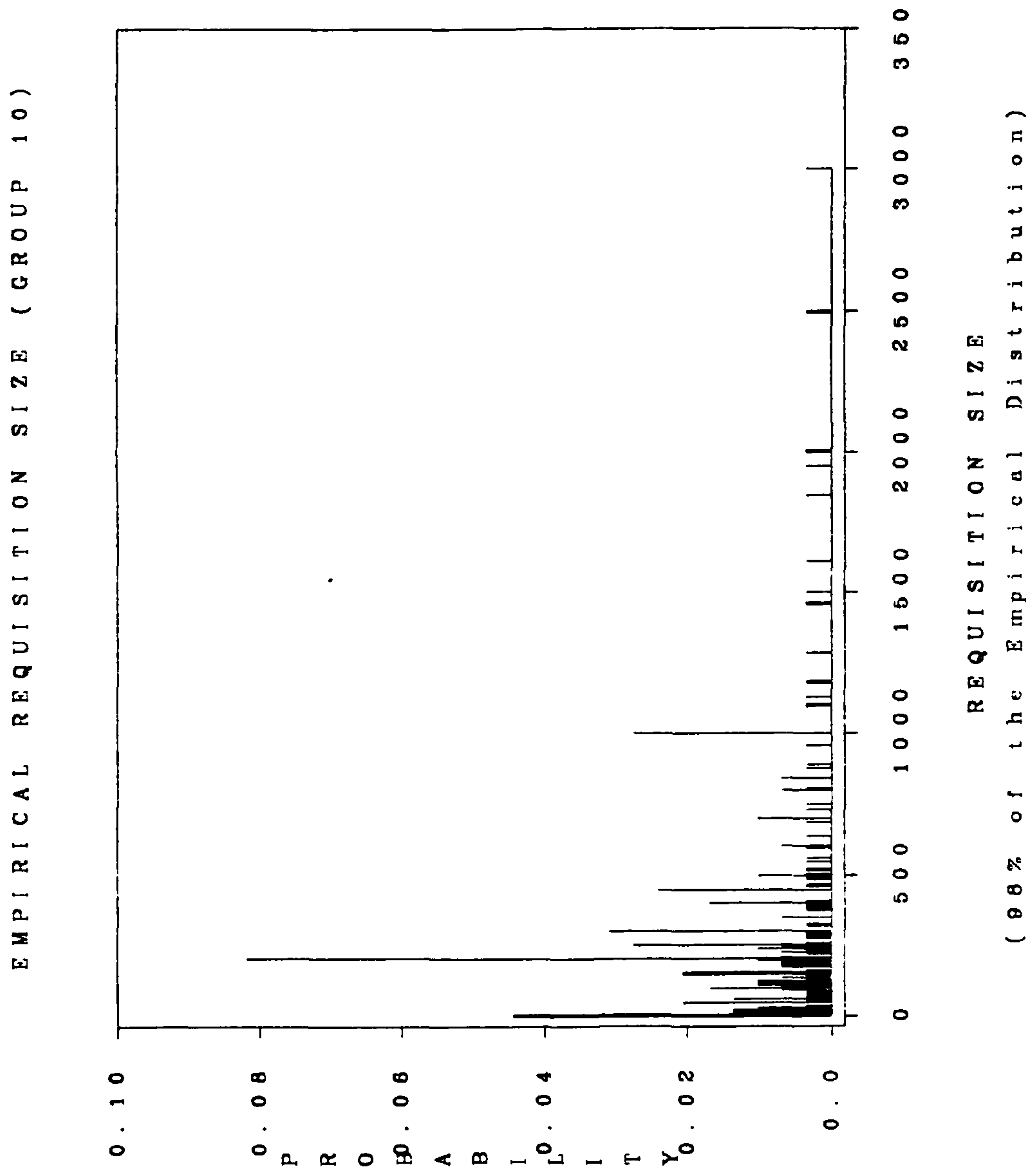
REQUISITION SIZE
(98% of the Empirical Distribution)

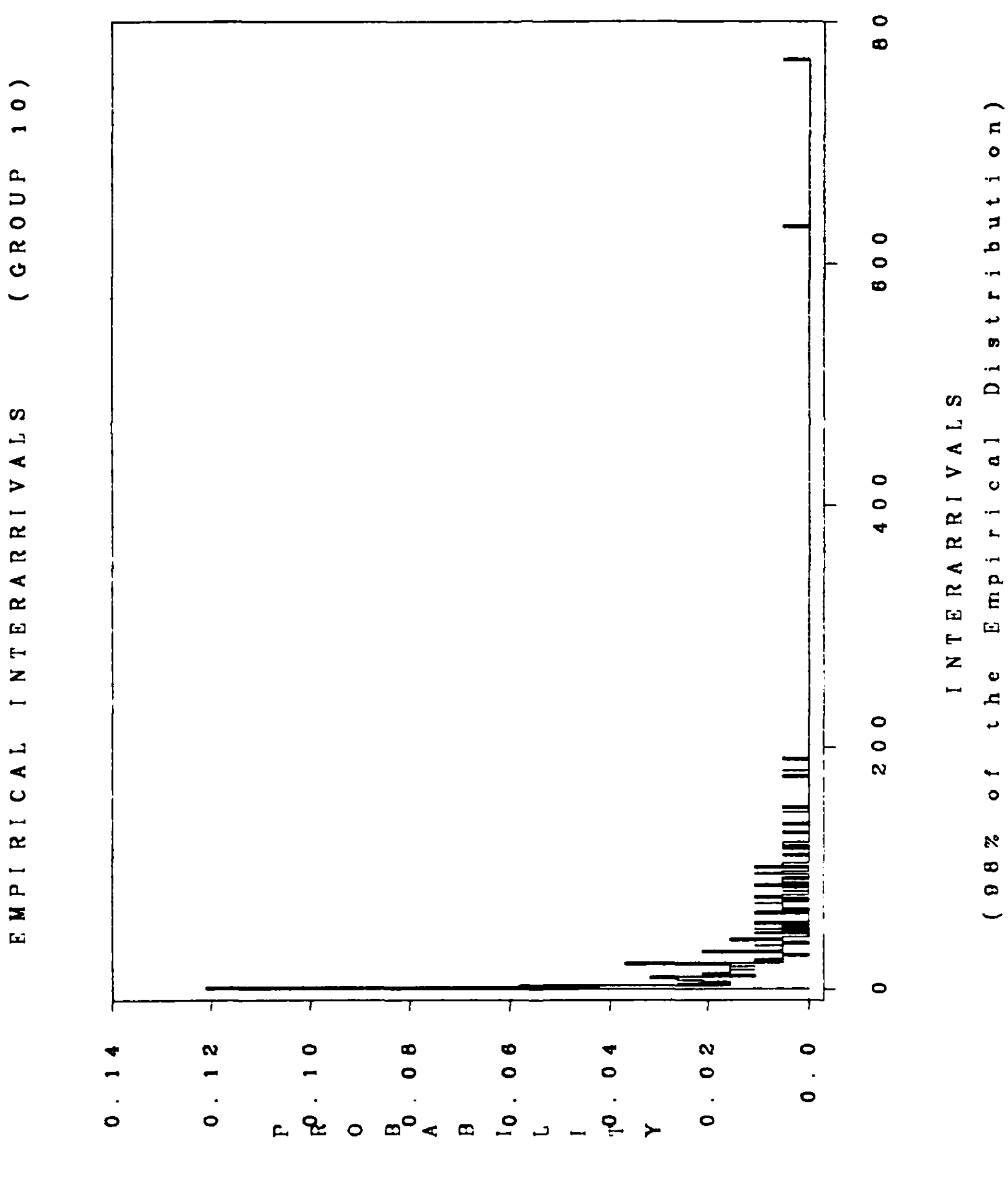

EMPIRICAL INTERARRIVALS (GROUP 8)
PROBABILITY
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
50
100
150
200
250
300
350
INTERARRIVALS
(98% of the Empirical Distribution)

EMPIRICAL REQUISITION SIZE (GROUP 9)

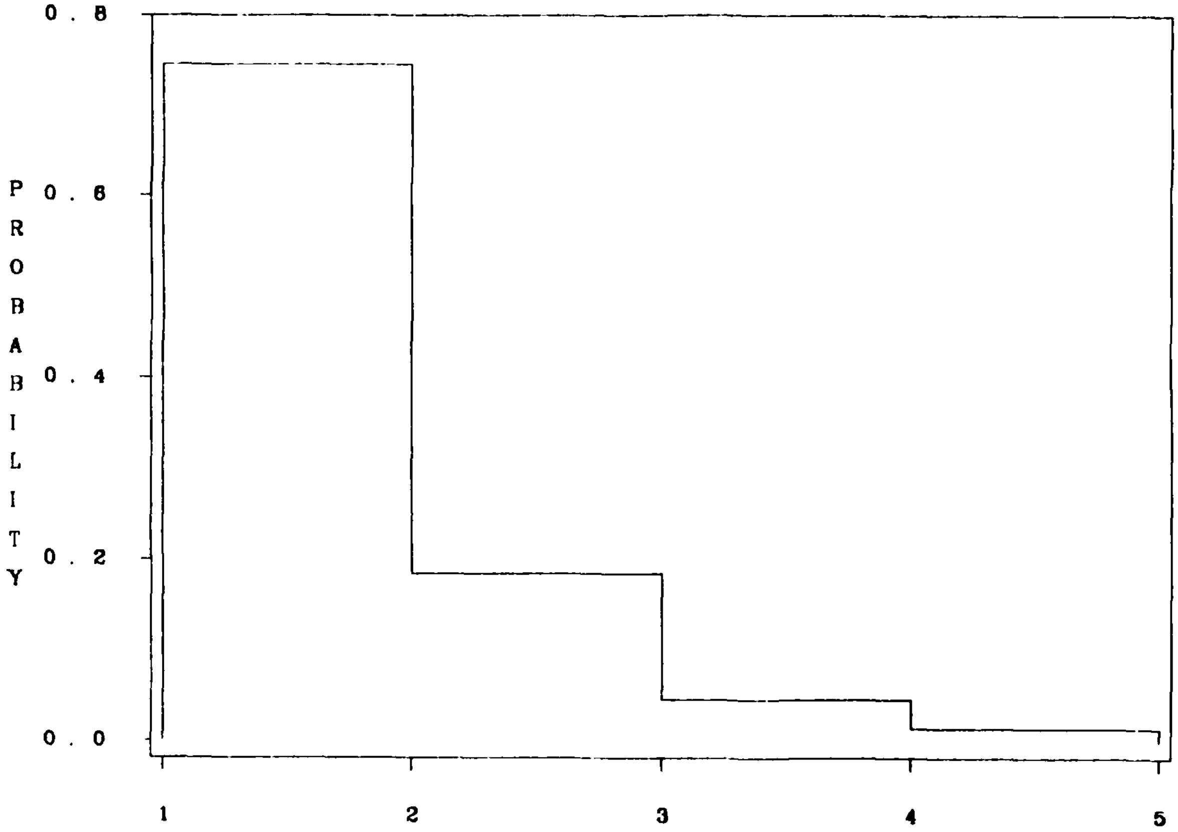



EMPIRICAL INTERARRIVALS (GROUP 9)
PROBABILITY
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
200
400
600
800
INTERARRIVALS
(98% of the Empirical Distribution)

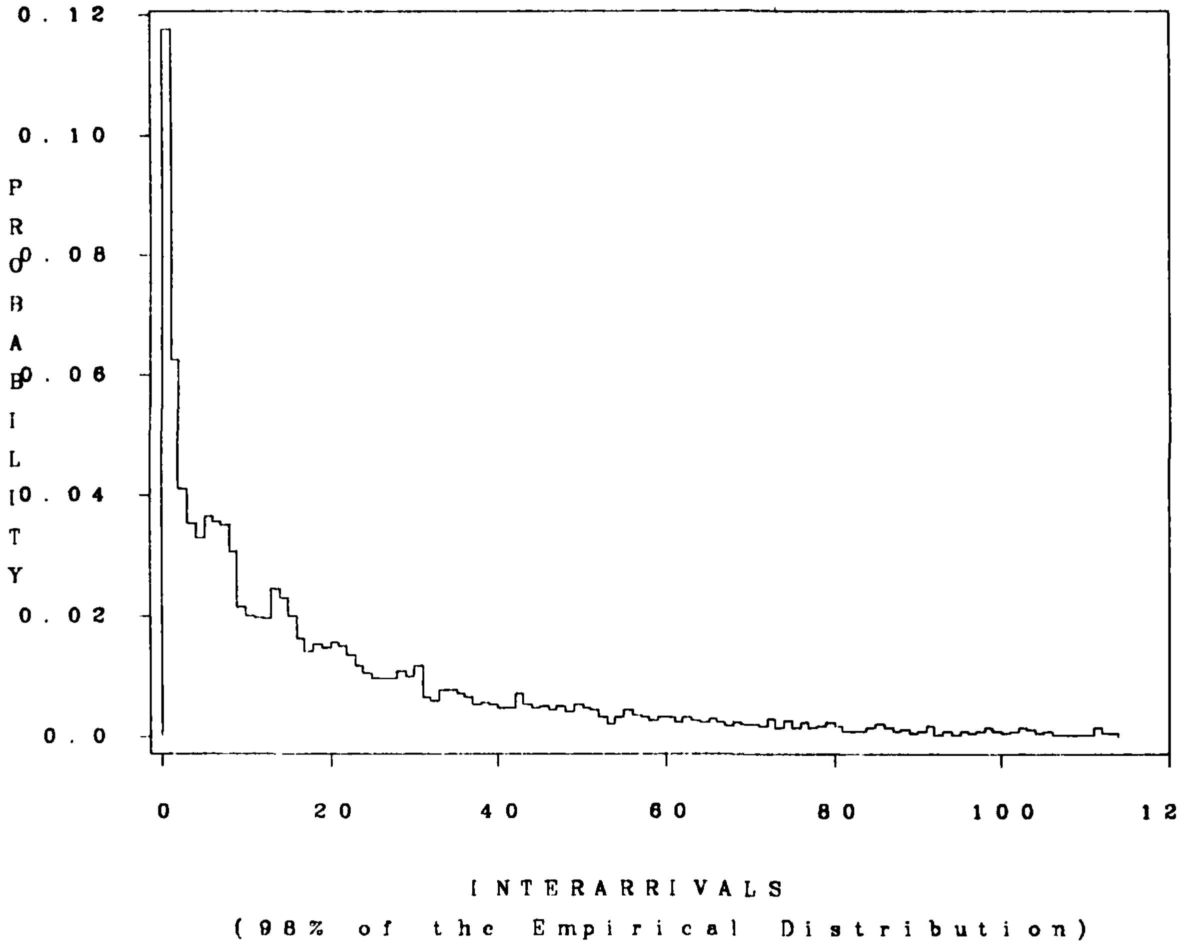

EMPIRICAL REQUISITION SIZE (GROUP 10)
PROBABILITY
0.10
0.08
0.06
0.04
0.02
0.0
0
500
1000
1500
2000
2500
3000
350
REQUISITION SIZE
(98% of the Empirical Distribution)

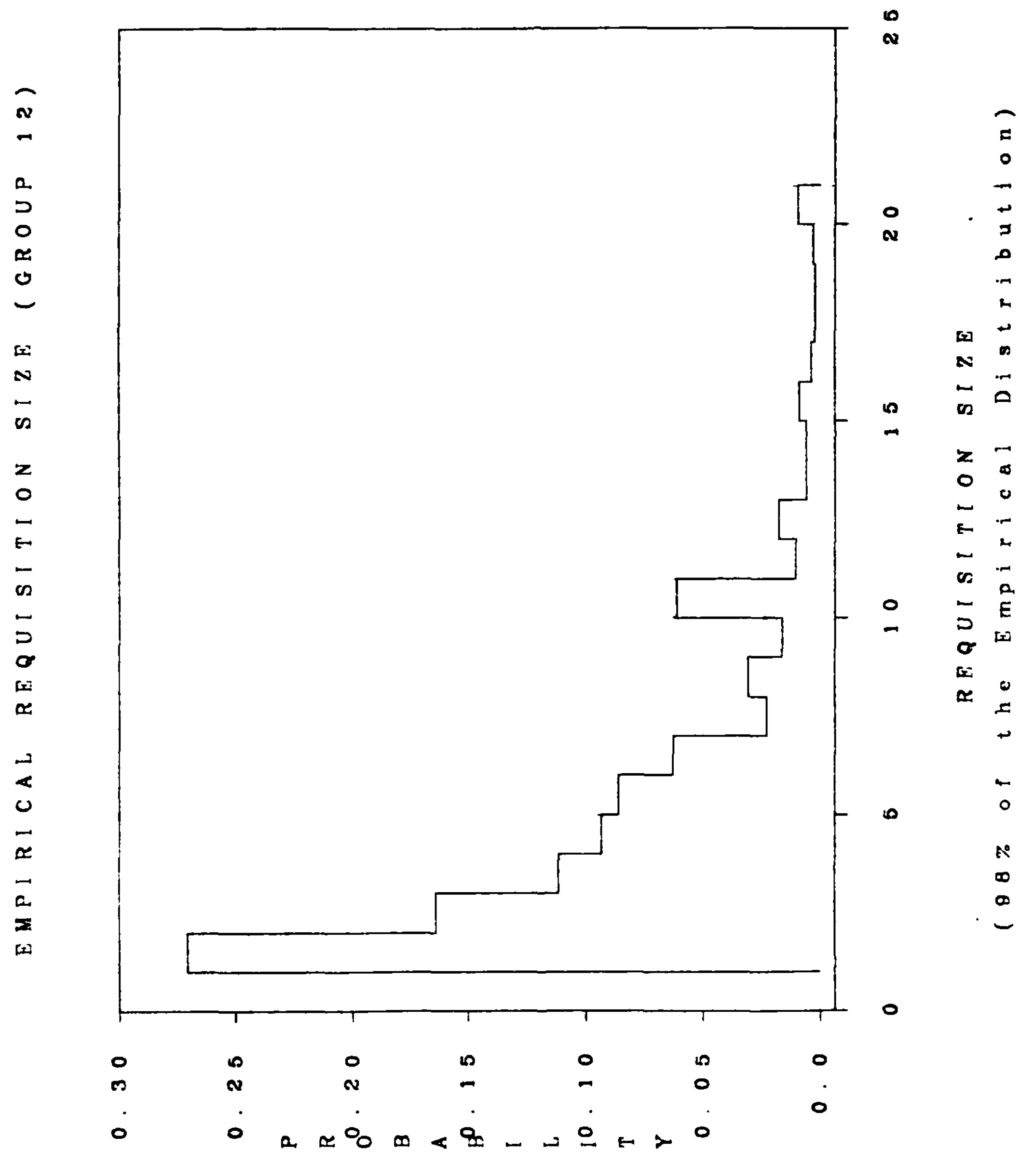

EMPIRICAL INTERARRIVALS (GROUP 10)
PROBABILITY
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
200
400
600
80
INTERARRIVALS
(98% of the Empirical Distribution)

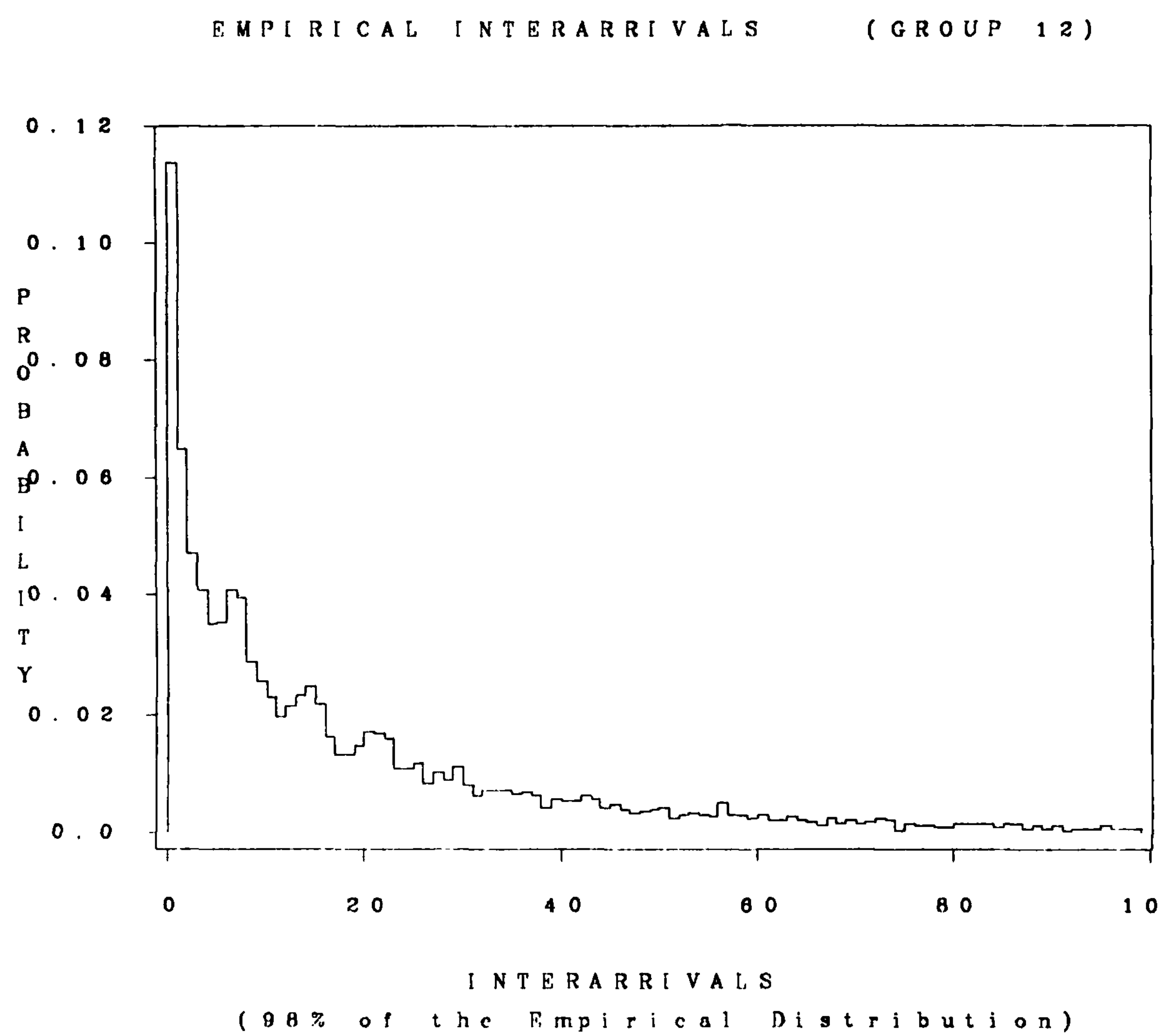
EMPIRICAL REQUISITION SIZE (GROUP 11)

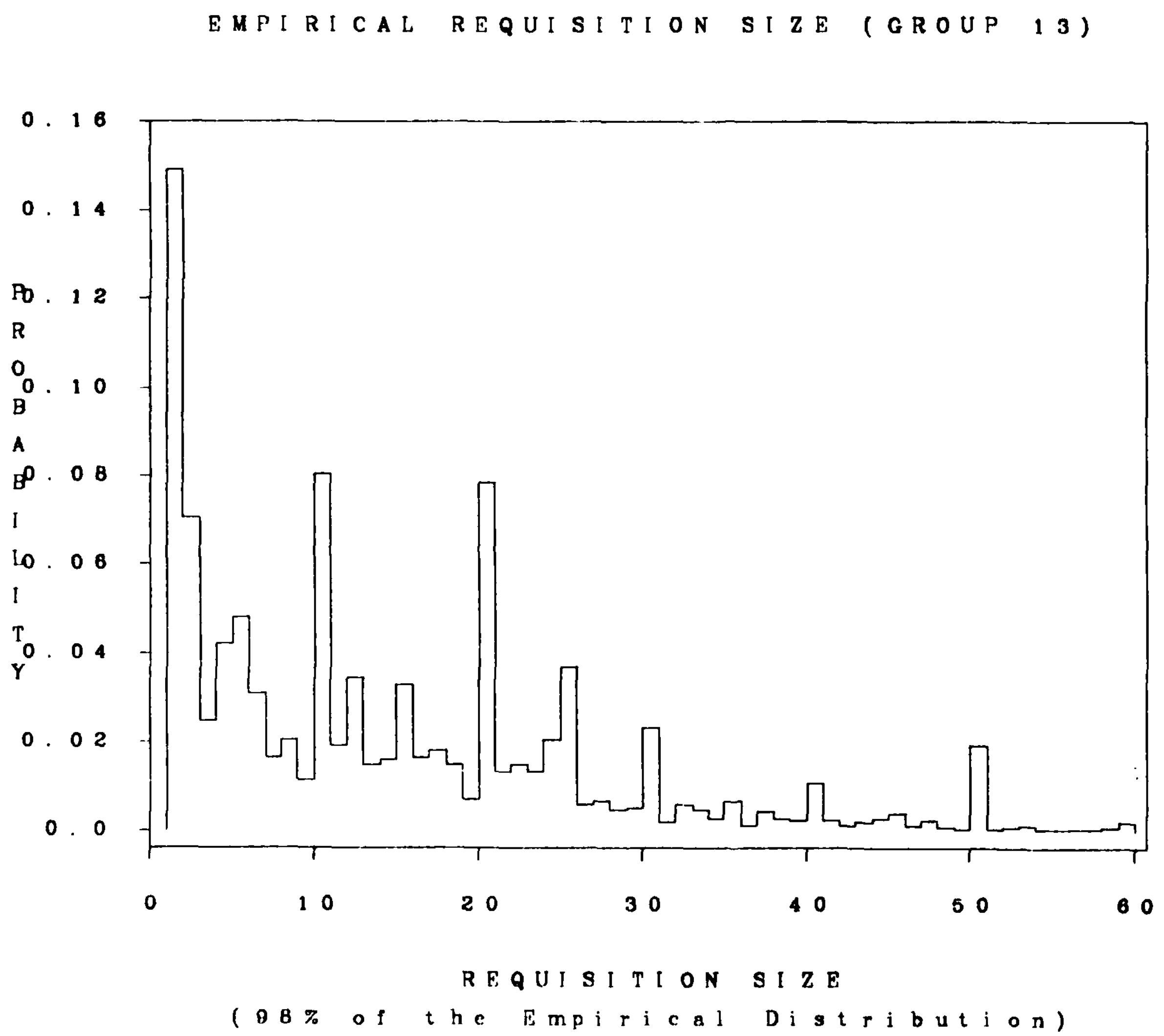


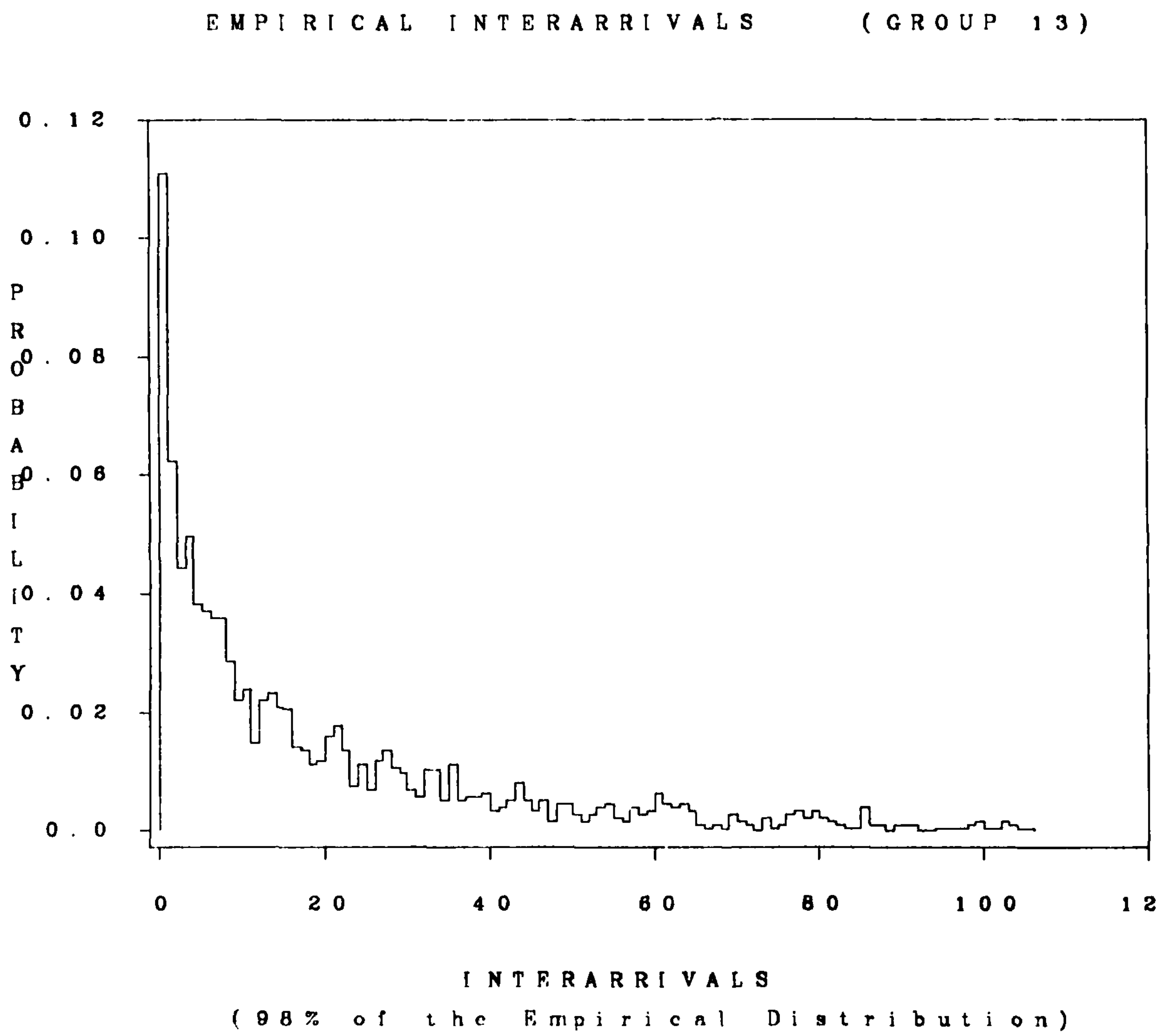
EMPIRICAL INTERARRIVALS (GROUP 11)



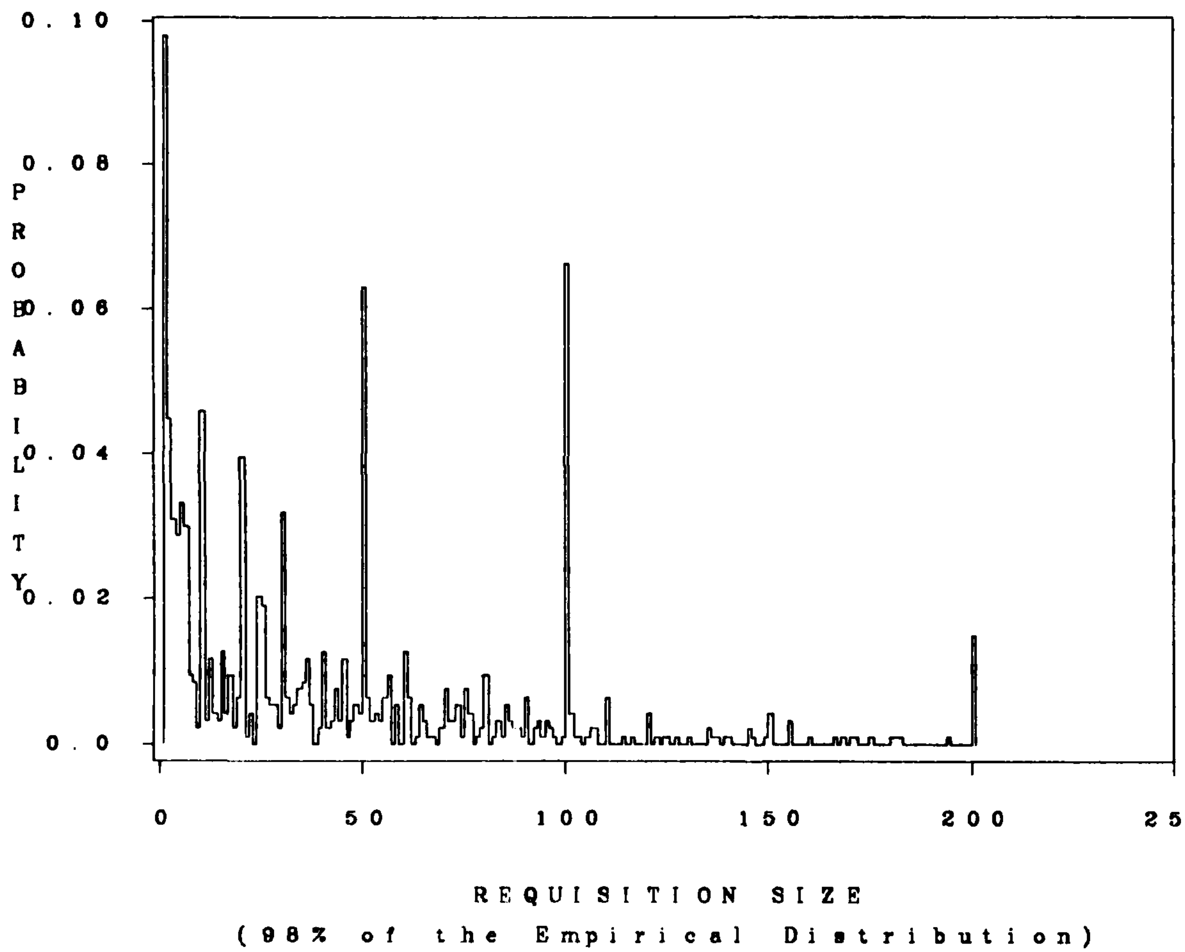

EMPIRICAL REQUISITION SIZE (GROUP 12)
PROBABILITY
0.30
0.25
0.20
0.15
0.10
0.05
0.0
0
5
10
15
20
25
REQUISITION SIZE
(98% of the Empirical Distribution)

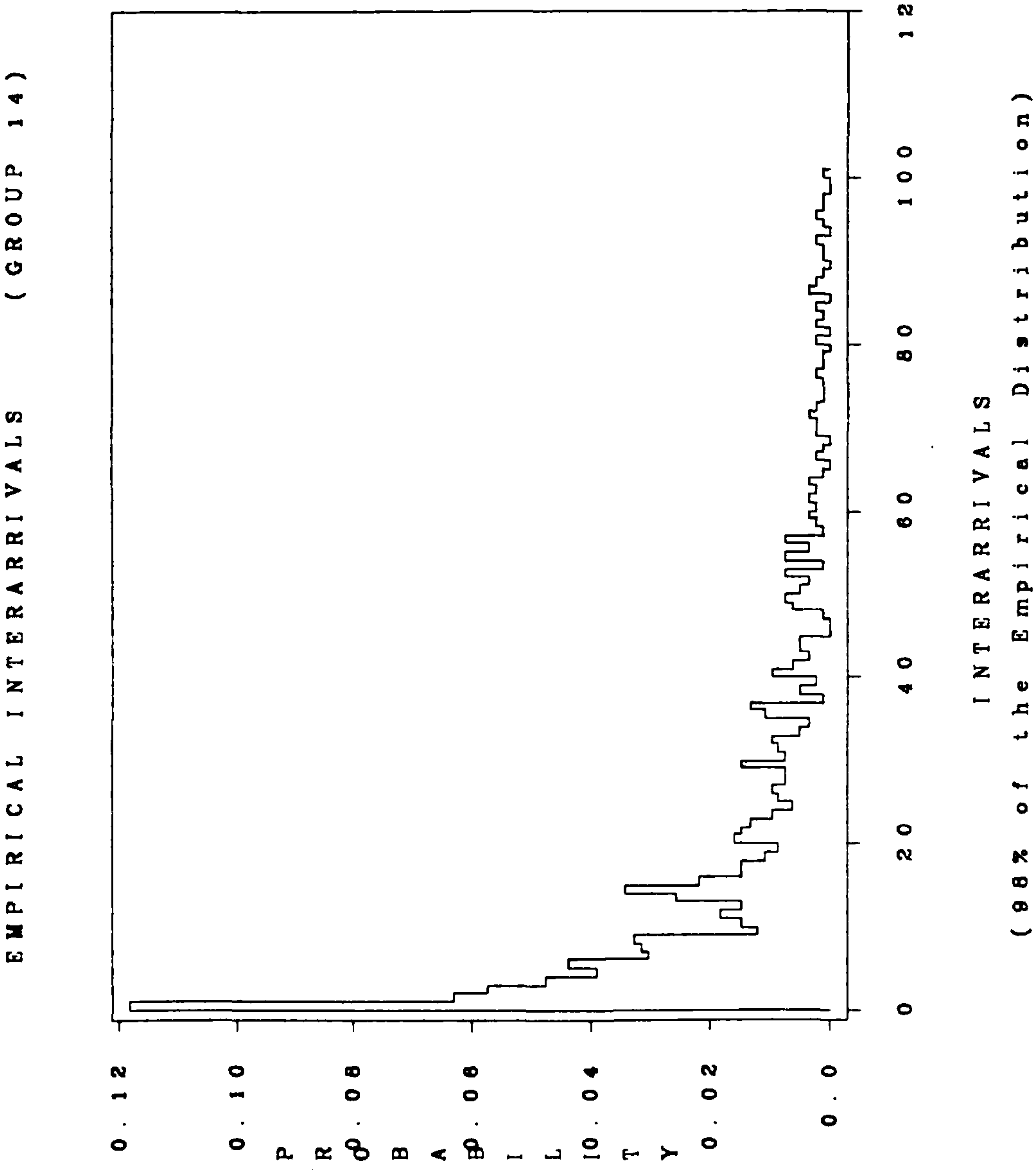

EMPIRICAL INTERARRIVALS (GROUP 12)
PROBABILITY
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
20
40
60
80
10
INTERARRIVALS
(98% of the Empirical Distribution)

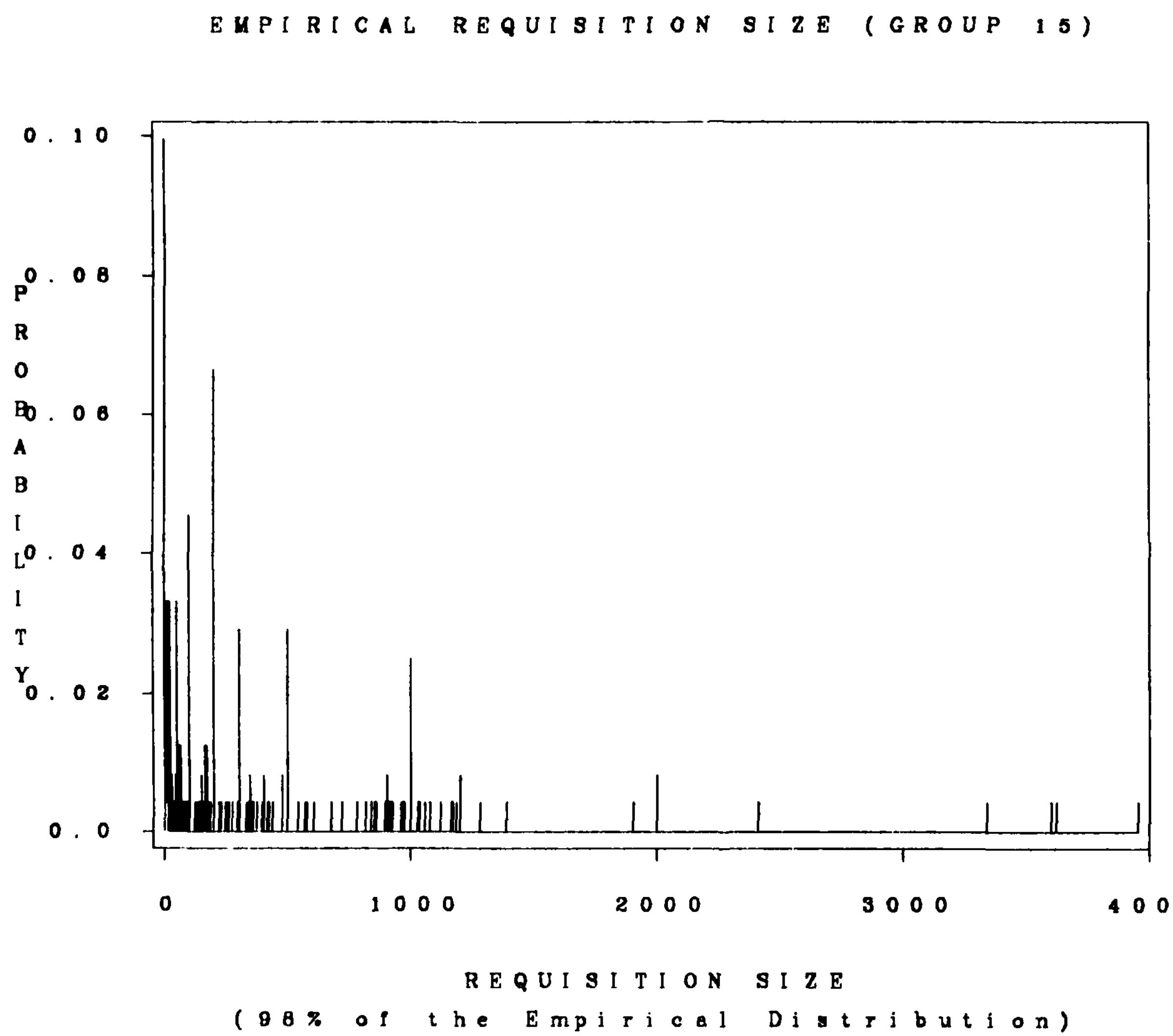

EMPIRICAL REQUISITION SIZE (GROUP 13)
PROBABILITY
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
10
20
30
40
50
60
REQUISITION SIZE
(98% of the Empirical Distribution)

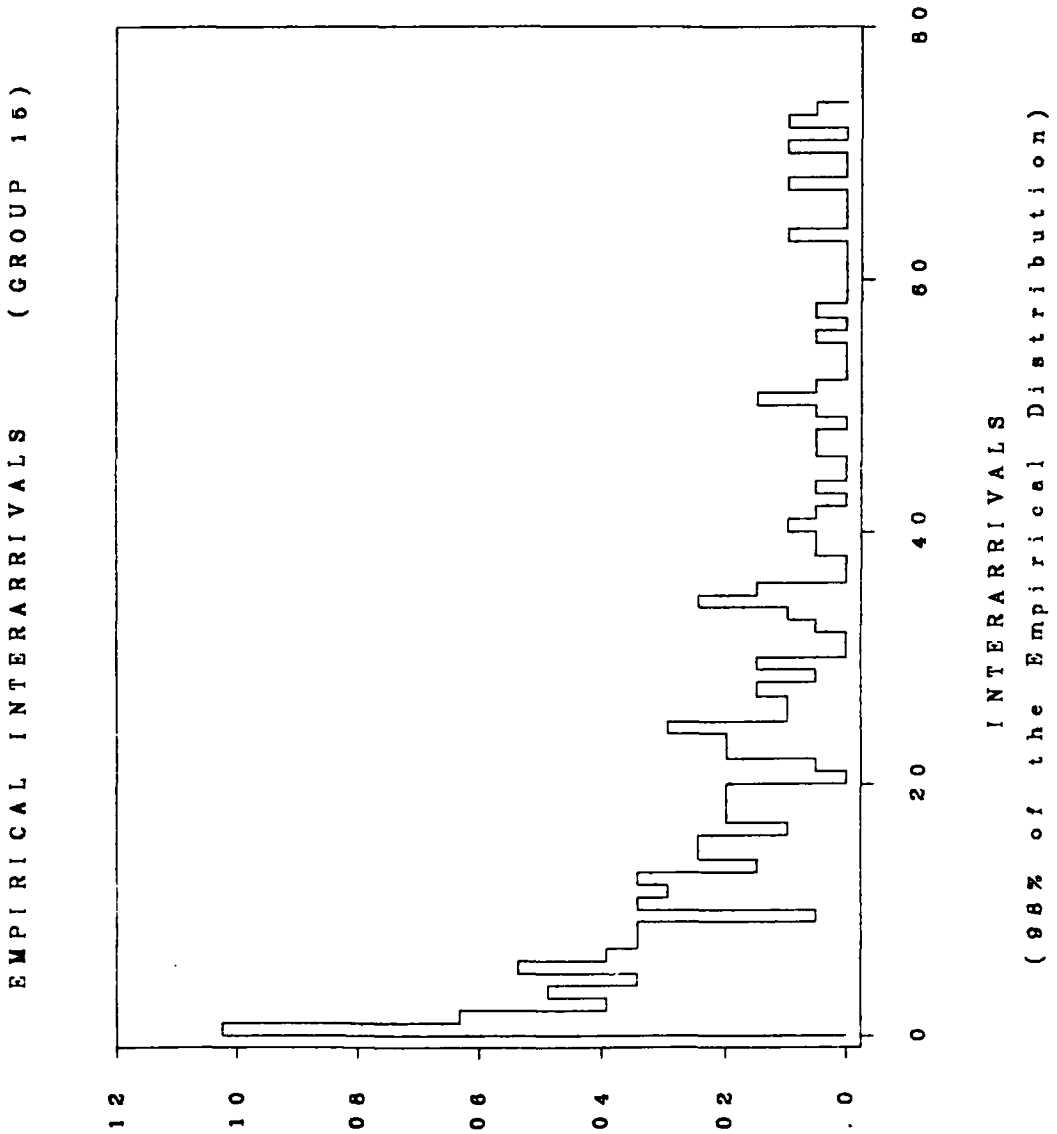

EMPIRICAL INTERARRIVALS (GROUP 13)
PROBABILITY
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
20
40
60
80
100
12
INTERARRIVALS
(98% of the Empirical Distribution)

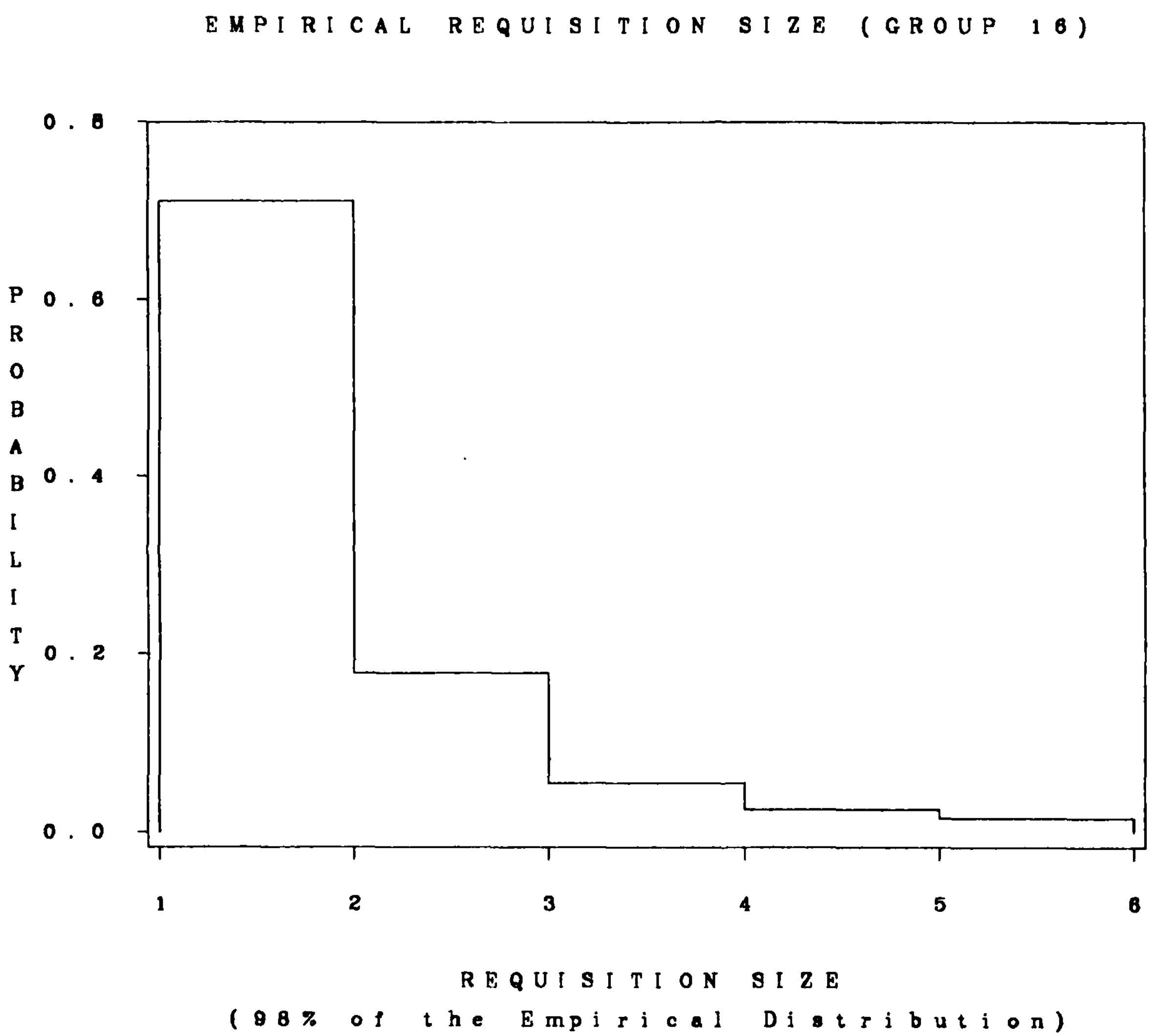
EMPIRICAL REQUISITION SIZE (GROUP 14)




EMPIRICAL INTERARRIVALS (GROUP 14)
PROBABILITY
0.0
0.02
0.04
0.06
0.08
0.10
0.12
0
20
40
60
80
100
120
INTERARRIVALS
(98% of the Empirical Distribution)

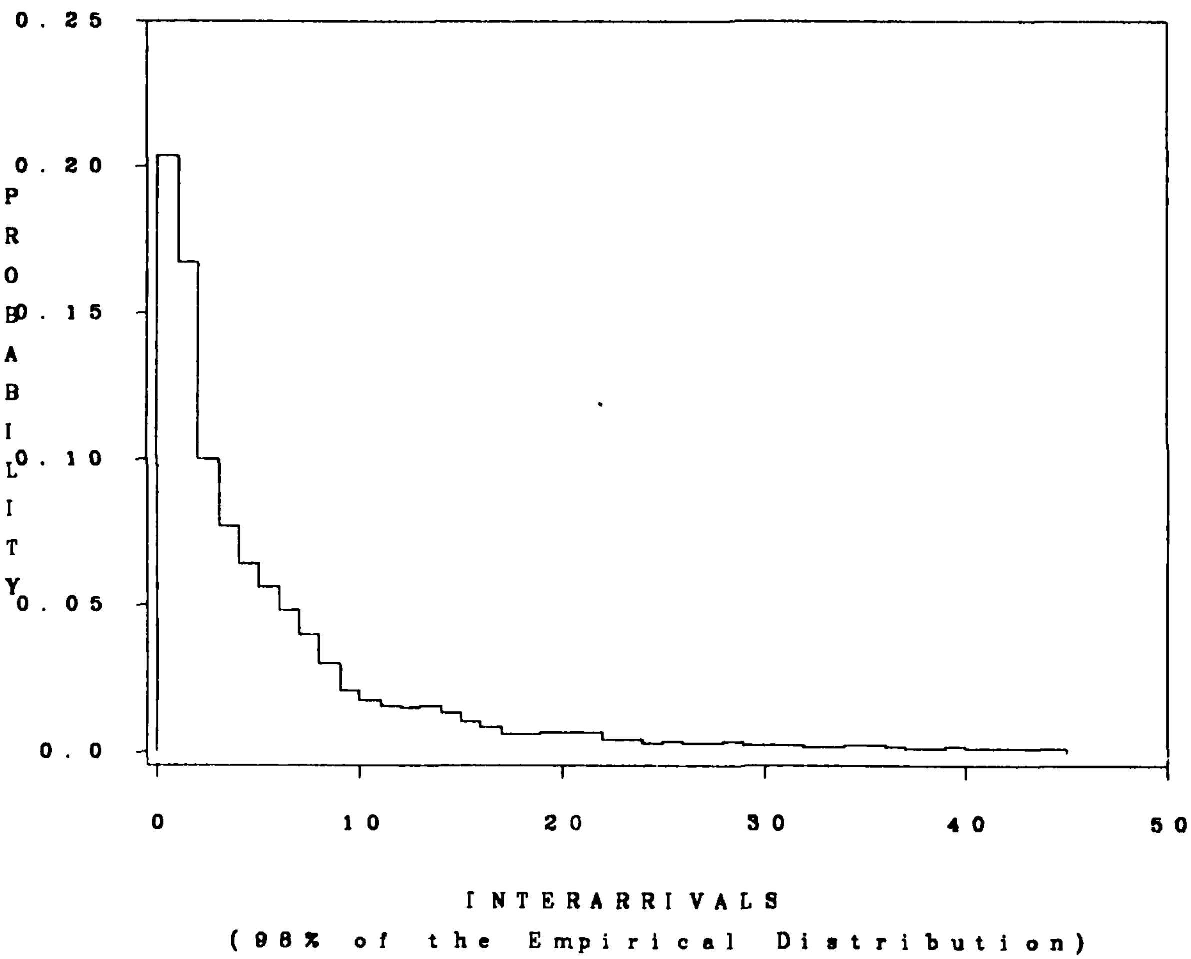

EMPIRICAL REQUISITION SIZE (GROUP 15)
PROBABILITY
0.10
0.08
0.06
0.04
0.02
0.0
0
1000
2000
3000
400
REQUISITION SIZE
(98% of the Empirical Distribution)


EMPIRICAL INTERARRIVALS (GROUP 15)
PROBABILITY
0.12
0.10
0.08
0.06
0.04
0.02
0.0
0
20
40
60
80
INTERARRIVALS
(98% of the Empirical Distribution)

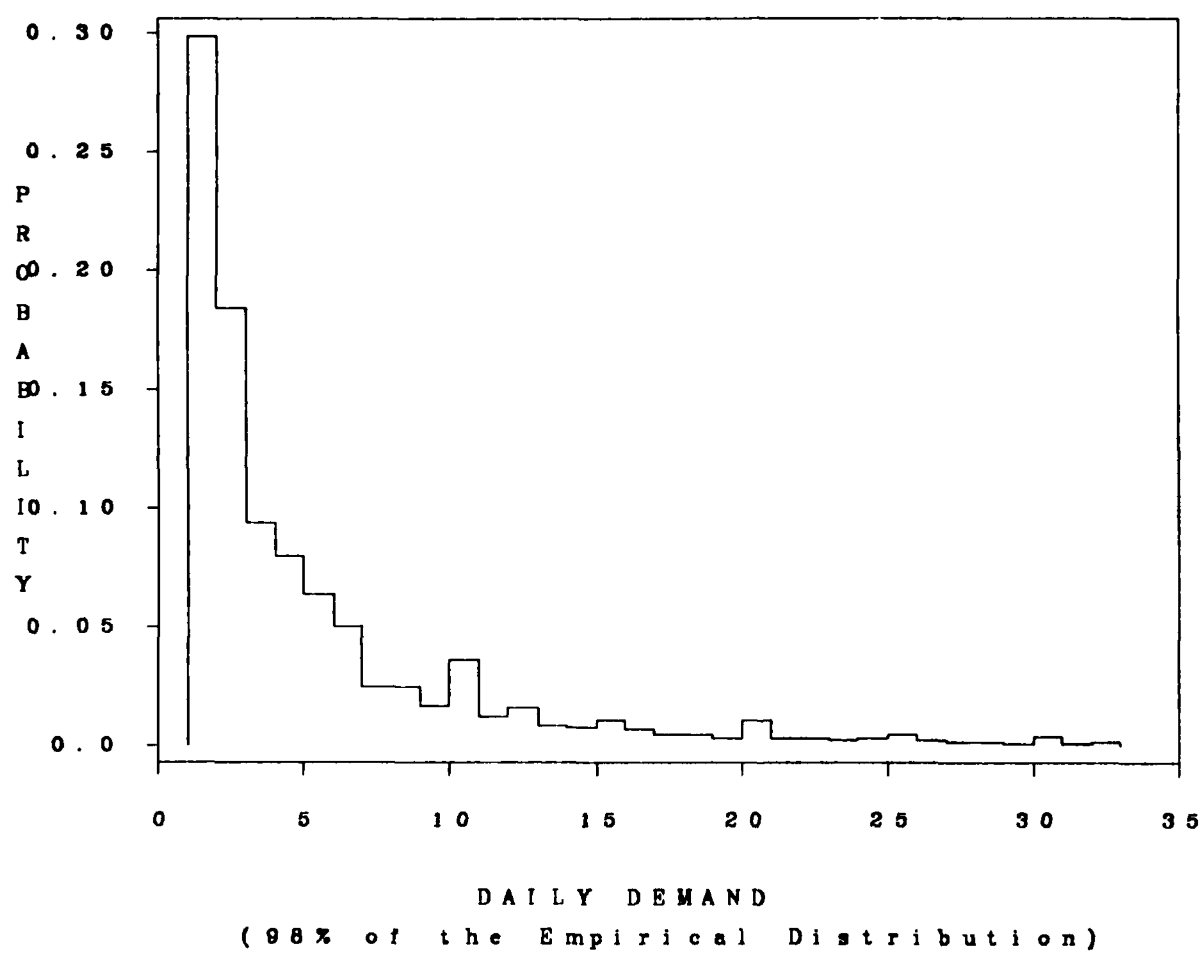


EMPIRICAL REQUISITION SIZE (GROUP 16)
PROBABILITY
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
REQUISITION SIZE
(98% of the Empirical Distribution)

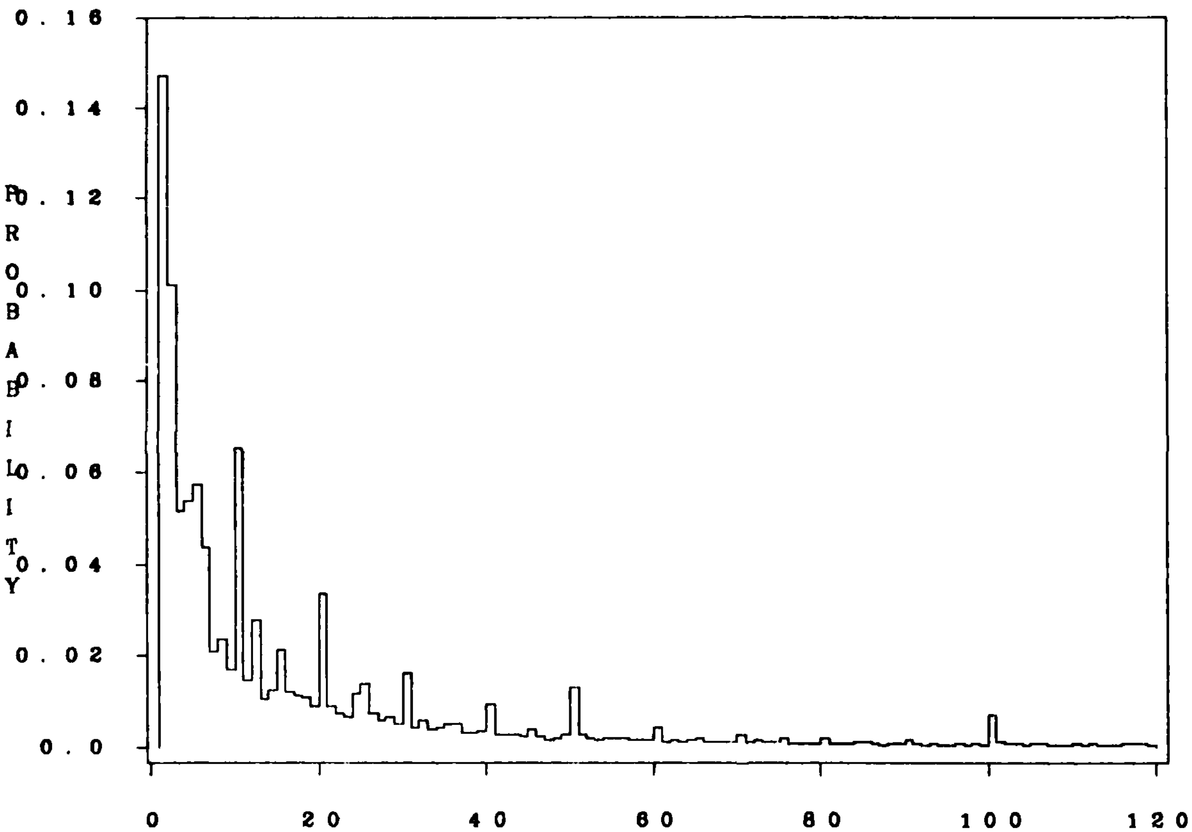
EMPIRICAL INTERARRIVALS (GROUP 16)



EMPIRICAL DAILY DEMAND (GROUP 17)

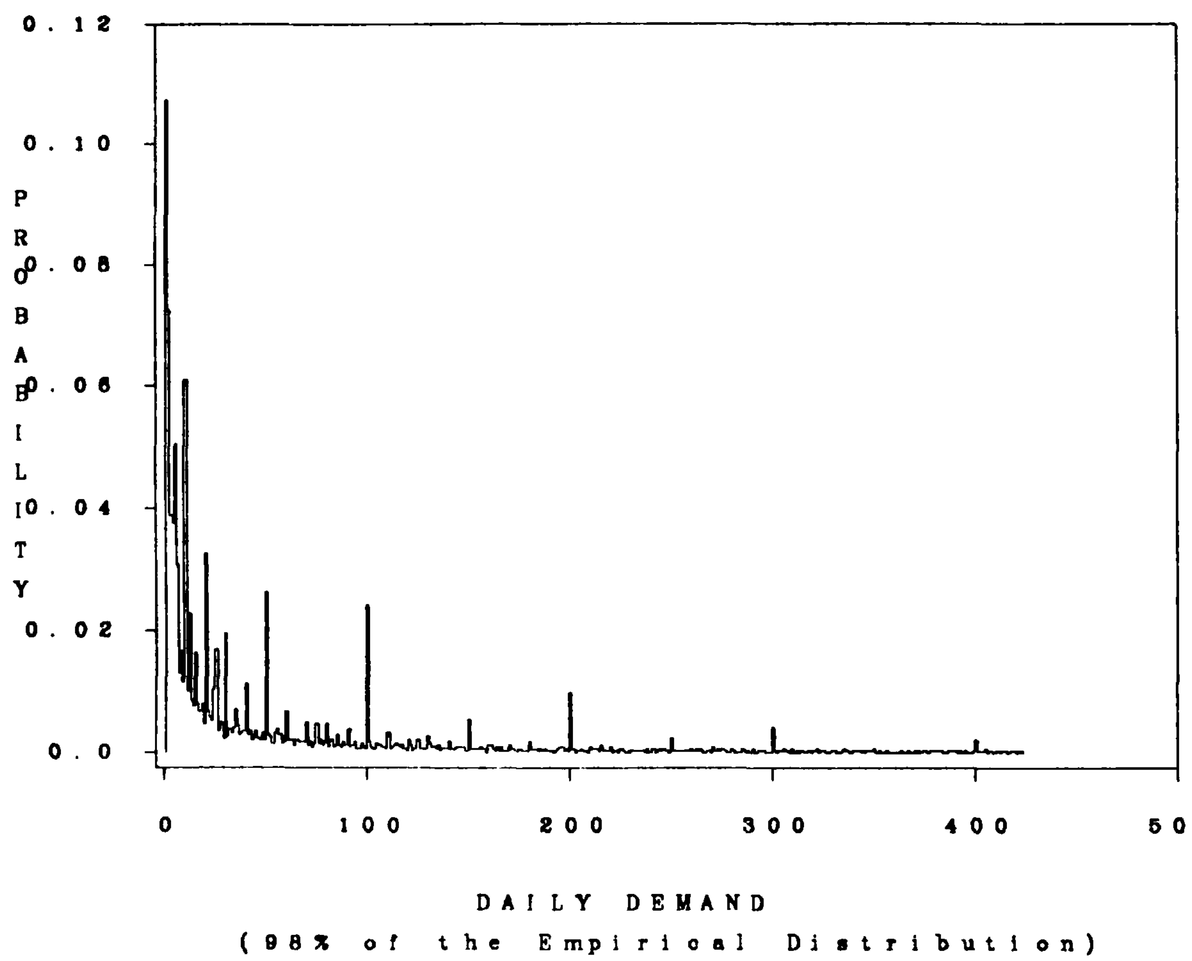


EMPIRICAL DAILY DEMAND (GROUP 18)

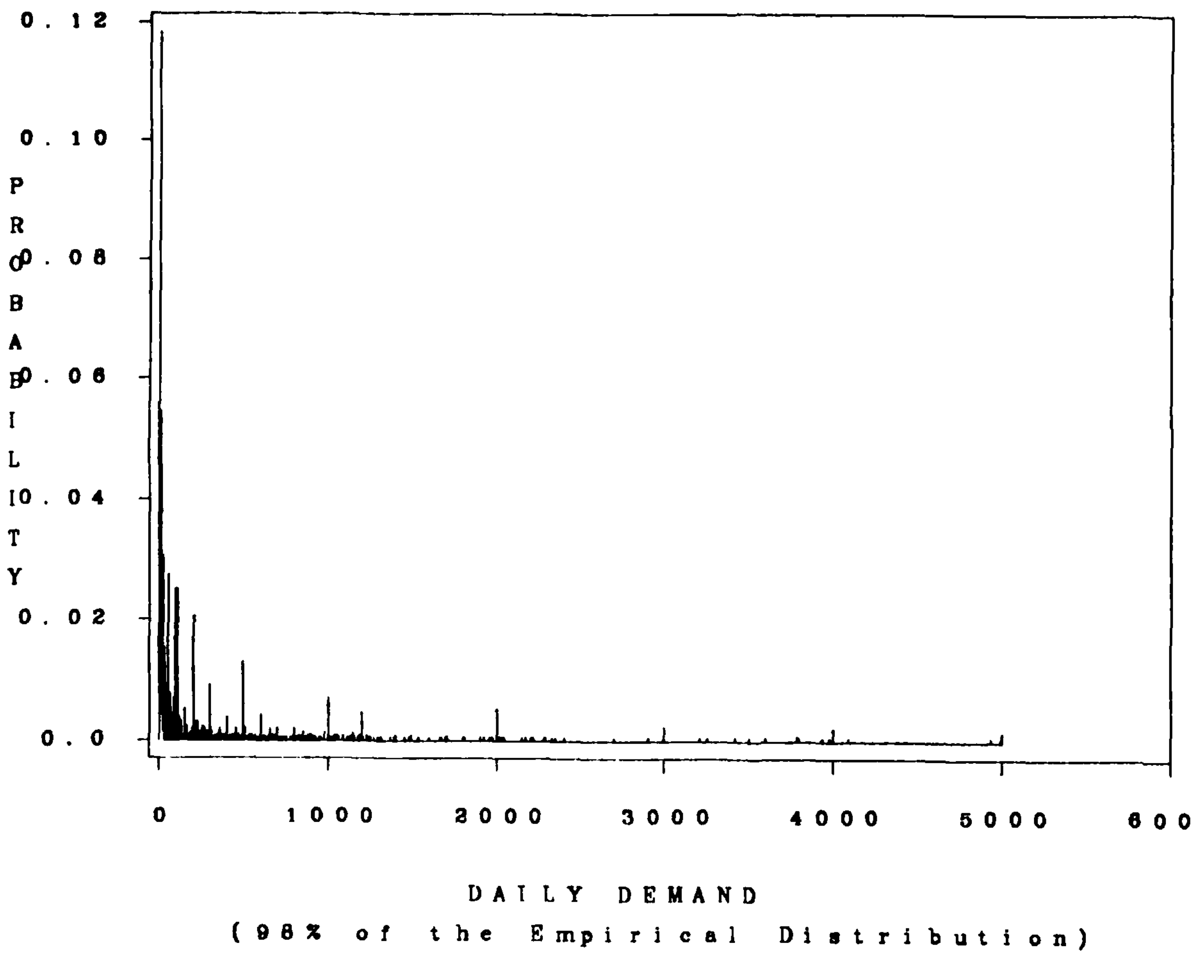


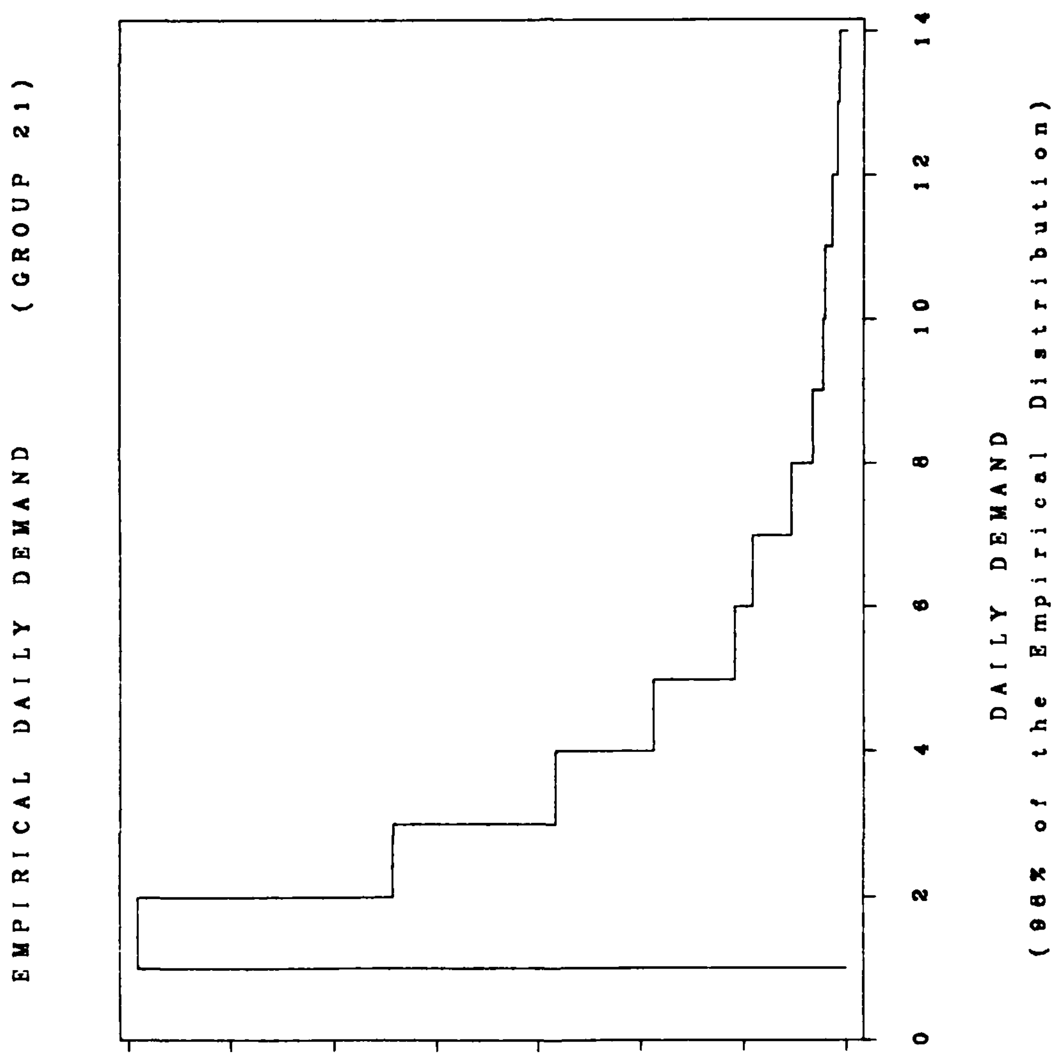
DAILY DEMAND
(98% of the Empirical Distribution)

EMPIRICAL DAILY DEMAND (GROUP 19)

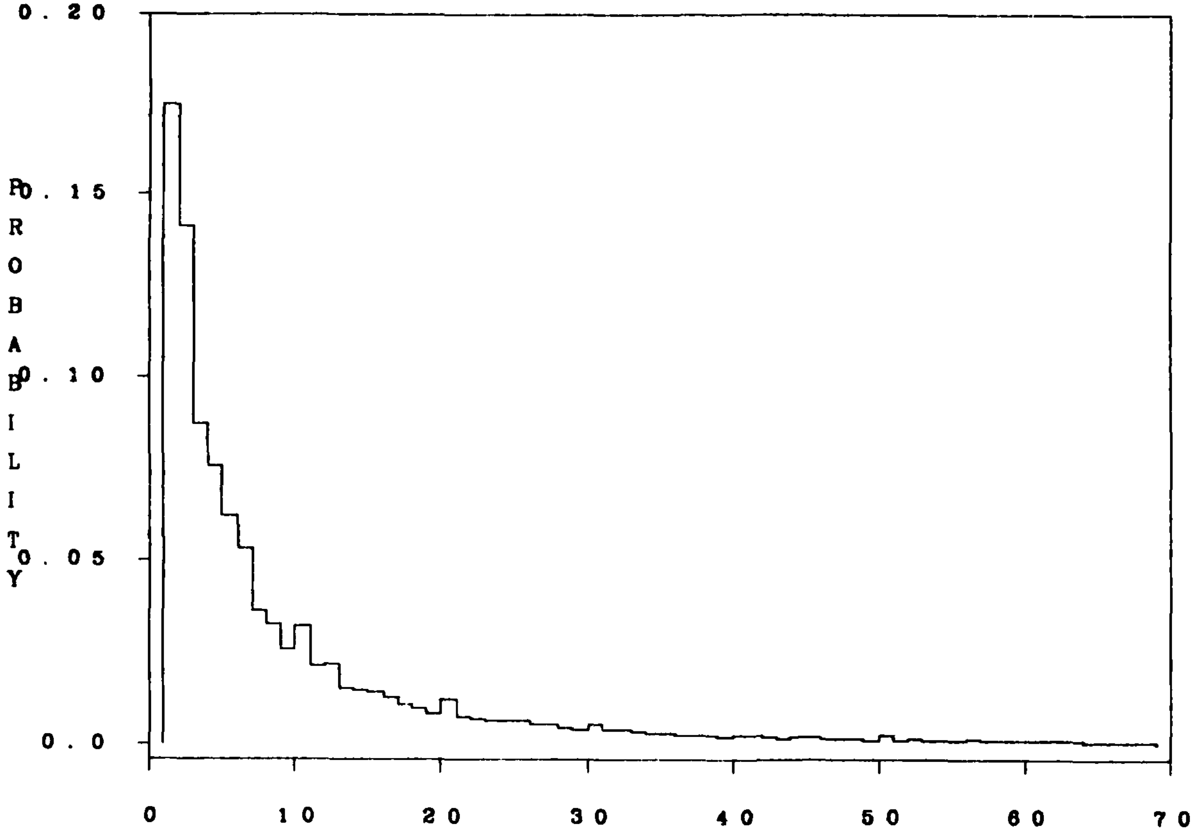


EMPIRICAL DAILY DEMAND (GROUP 20)

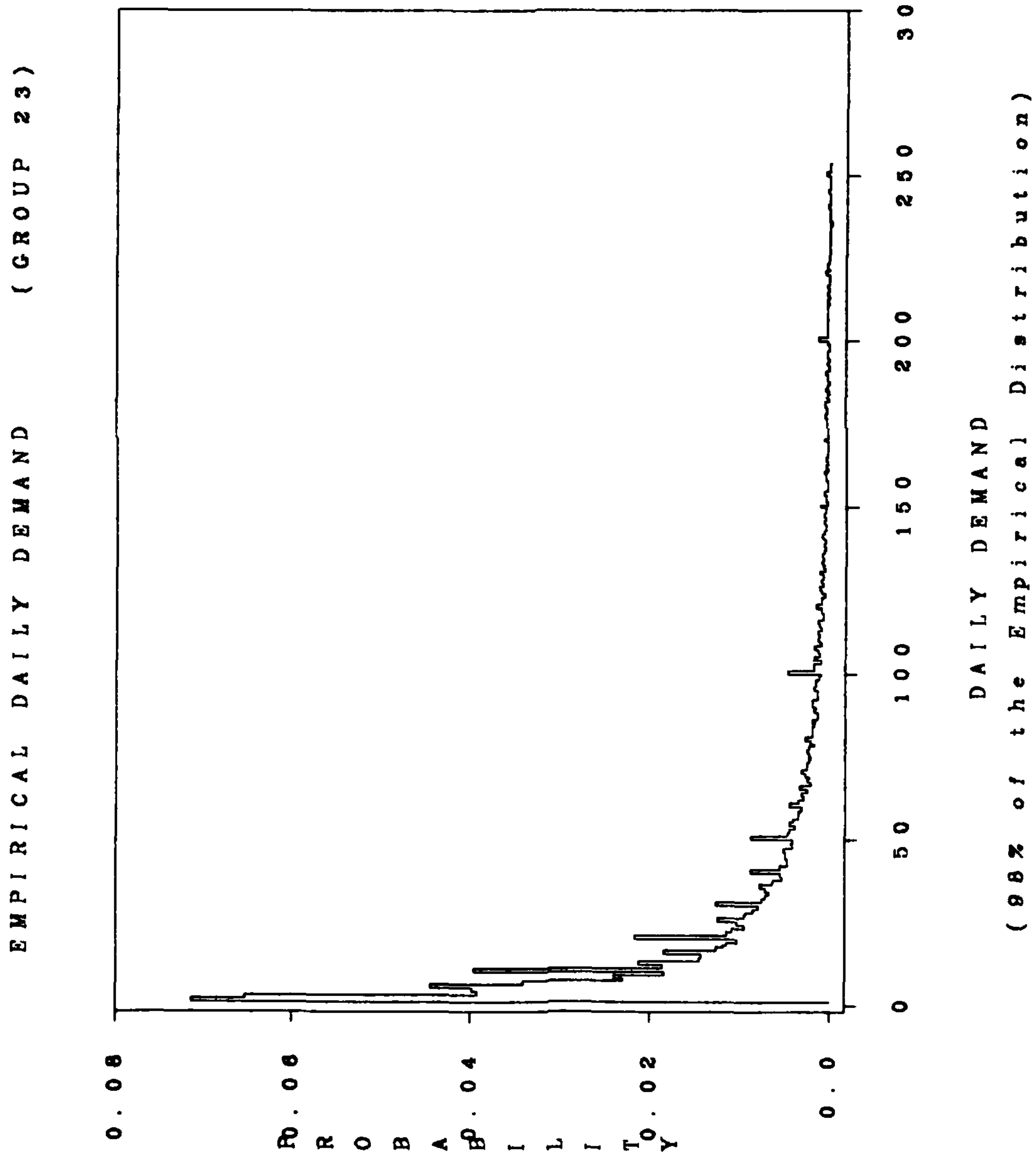


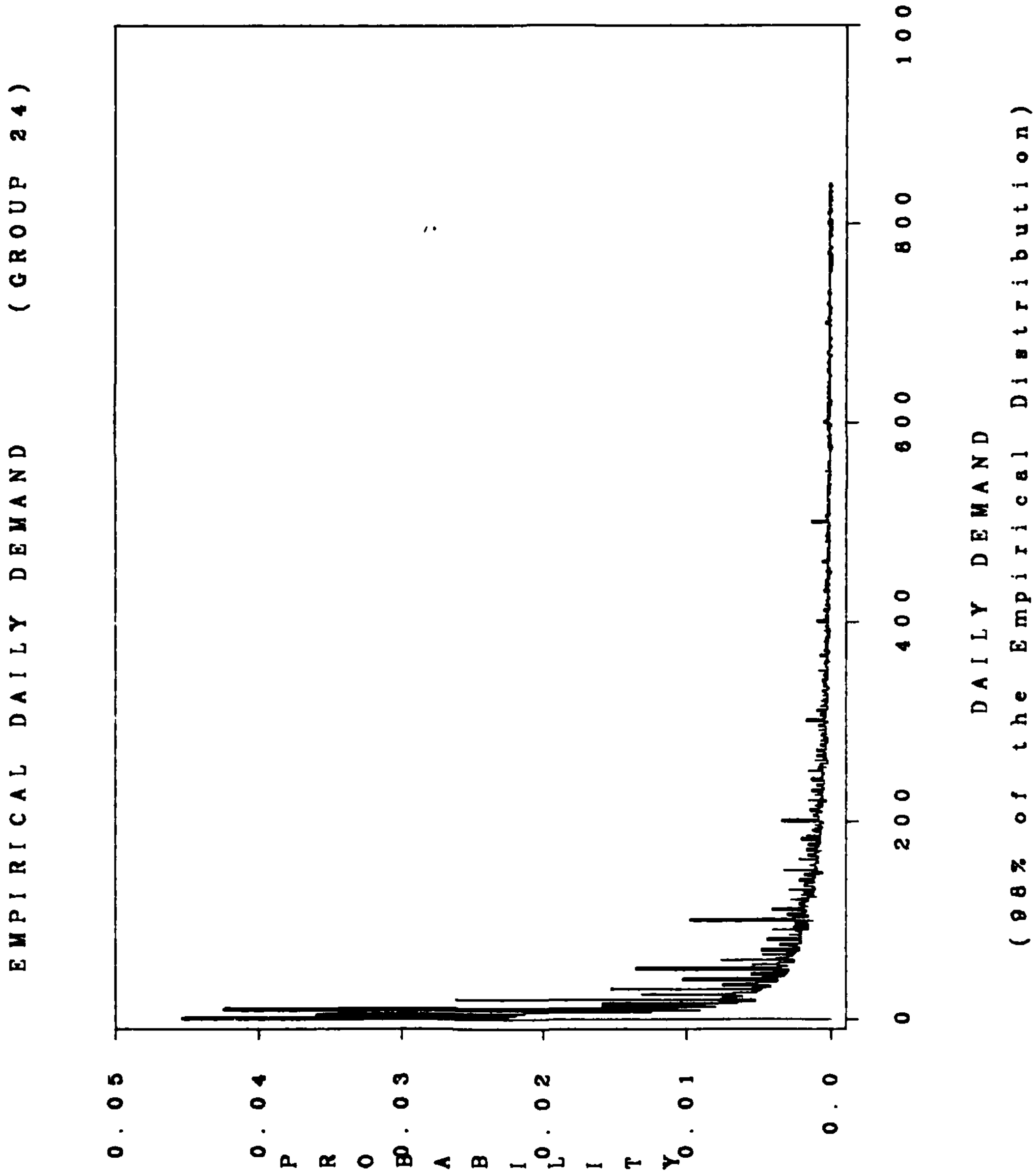

EMPIRICAL DAILY DEMAND (GROUP 21)
PROBABILITY
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.0
0
2
4
6
8
10
12
14
DAILY DEMAND
(98% of the Empirical Distribution)

EMPIRICAL DAILY DEMAND (GROUP 22)

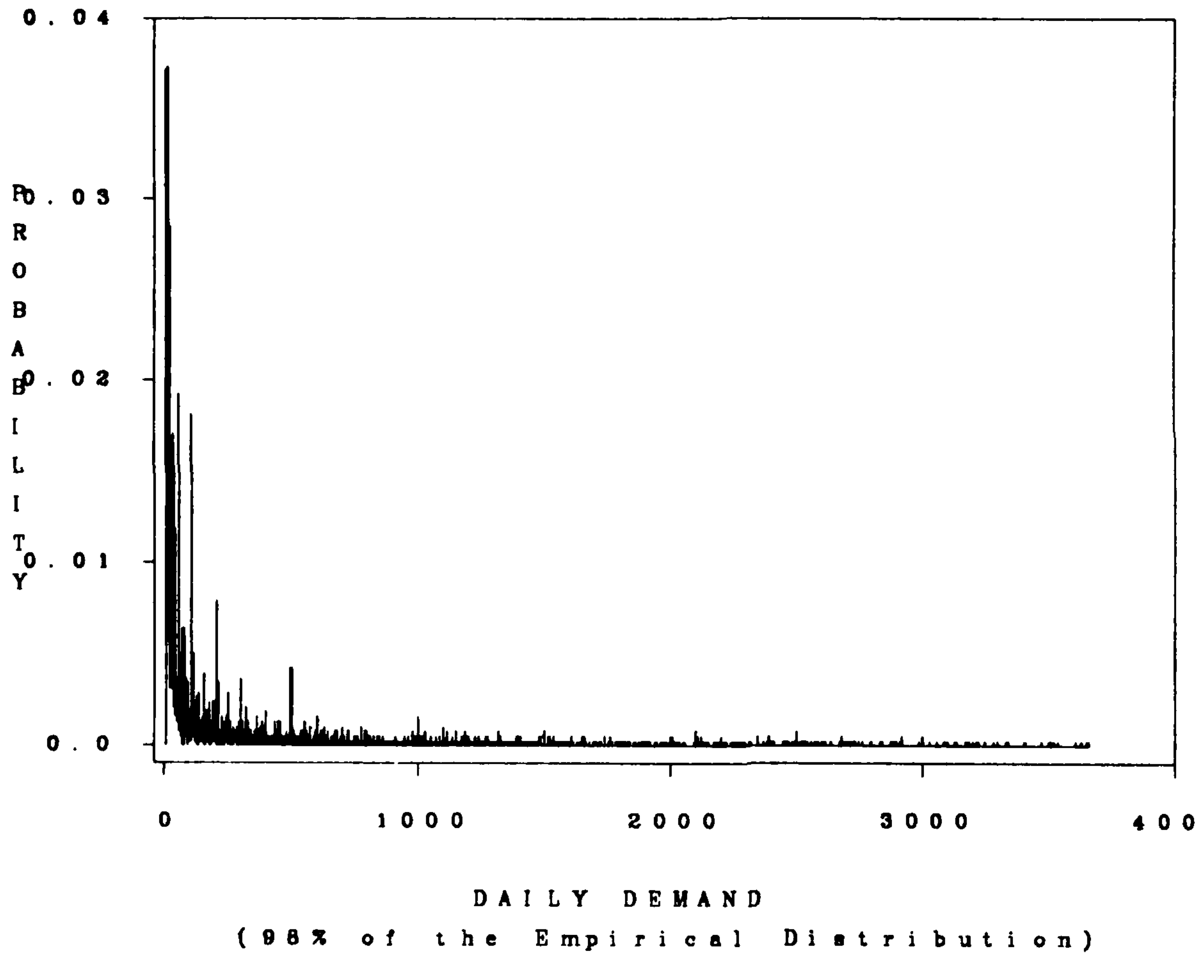


DAILY DEMAND
(98% of the Empirical Distribution)


EMPIRICAL DAILY DEMAND (GROUP 23)
PROBABILITY
0.0
0.02
0.04
0.06
0.08
0
50
100
150
200
250
300
DAILY DEMAND
(98% of the Empirical Distribution)


EMPIRICAL DAILY DEMAND (GROUP 24)
PROBABILITY
0.0
0.01
0.02
0.03
0.04
0.05
0
200
400
600
800
1000
DAILY DEMAND
(98% of the Empirical Distribution)

EMPIRICAL DAILY DEMAND (GROUP 25)



F.42

VITA

Captain Kevin P. Smith was born on 12 May 1958 in Duluth, Minnesota. He received a Bachelor of Science in Operations Research from the United States Air Force Academy in 1980 and was commissioned a second lieutenant in the United States Air Force. Upon commissioning, he was assigned to the Tactical Fighter Weapons Center/Studies and Analysis, Nellis Air Force Base, Nevada where he served as a Scientific Analyst from July 1980 to August 1981. He was then assigned to the Tactical Air Command Joint Studies Group, Langley Air Force Base, Virginia, where he again served as a Scientific Analyst until his entry into the School of Engineering, Air Force Institute of Technology, in May 1984.

Permanent Address: 520 Park Street

Duluth, Minnesota 55803

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